ASSESSMENT OF THE COMPETITIVE ADVANTAGE GENERATED BY RESEARCH OF GERMAN UNIVERSITIES:

an adaptation of Porter’s diamond and Four stages of competitive development models for use in higher education

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Don’t hope for Plato’s utopian republic, but be content with the smallest step forward, and regard even that result as no mean achievement.

Marcus Aurelius, 2006, p. 89.

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ABSTRACT

University performance assessment emerged as an active and growing field of research alongside the emergence of neoliberalism in the public sector in the 1980s. With increased interest in evaluation methodologies and their application two knowledge gaps emerged: (1) the absence of a universal method to assess the performance of universities; (2) a lack of knowledge and expertise to perform these evaluations.

The direction of the present research in pursuance of closing the identified knowledge gaps was determined to a great degree by the consideration that when universities are predominantly viewed as corporate enterprises, an investigation into the assessment of the performance of universities should explore and exploit the lessons to be learned from the corporate sector. Here, the review of the literature hinted at using Porter's seminal diamond model as a generic approach to assess the competitive strength of higher education institutes.

The contribution to methods in the present research includes the identification of the key attributes of each corner of the diamond and their relative importance in the determination of the competitive condition of the diamond for the assessed universities. In addition, there is an adaptation of Porter's *Four stages of competitive development* model and *thematic maps* providing illuminating insights into the process of creating and upgrading competitiveness in research.

The contribution to professional practice in this thesis is that its findings help university decision makers frame the numerous determinants of research performance into a coherent pattern so providing them with a succinct overview of the competitive condition of the university and simultaneously avoiding an information overflow.

The discoveries in the present research will enable university decision makers to understand the cause-and-effect relationships between the determinants and performance better and will give direction to strategy development.

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CHAPTER 1: INTRODUCTION

The aim of this chapter is to establish the boundaries of the present research and to determine the context and significance of the study being conducted. For this purpose, a summary of the current understanding and background to the research is presented together with a reference to the emerging gap in the literature. This is followed by an outline of the purpose of the research via the principal research question from which other research questions emanate. The next section of the chapter outlines the methodological approach used to structure the research and to examine the research problems. This is followed by highlighting the potential outcomes that the study discloses. The chapter ends with a few concluding remarks.

The present research can be located in the domain of performance measurement. This domain is one of incredible diversity, with researchers contributing from backgrounds as diverse as accounting, operations management, finance, economics, psychology, sociology, anthropology and the more recent bibliometrics[1]. A significant barrier in the progress of this field of enquiry is the functional specialisation of its researchers, leading to “deep and rich streams of functionally specialised research, often with limited cross-fertilisation” (Neely, 2007, p. 7). The present study therefore seeks to create cross-fertilisation by bringing knowledge together from different areas of investigation. The study focuses on performance measurement in higher education and seeks to help university decision-makers attain their strategic goals by improving the understanding of how university performance in research is created and develops. More specifically this study focuses on university performance in research of German universities. However, it should be pointed out that this is not because a focus on performance in education or on universities in a different geographic area is not an equally challenging field of enquiry, but because the focus of this study has developed in the last decade when the author was working for the world’s largest academic publisher in that

[1] Bibliometrics = “the application of mathematics and statistical methods to books and other media of communication” (Pritchard, 1969, p. 349).

country. It is also anticipated that the findings from this study will have a direct impact on the author's professional practice. Moreover, while the present research seeks to explore and develop extant professional practice, provides the context in which the study is set the instrumental evidence of its value-in-use.

1.1 The Importance of the Present Research

Congruent with the neoliberal free market philosophy, many countries presently favour the principle that research funding should go to universities that are efficient and can attract students (Johnes and Johnes, 1995, p. 301). This aim is rooted in the context of New Public Management (NPM). Within the context of NPM during the last three decades a trend has emerged where governments have reduced the regulation of universities and simultaneously created incentives to make universities more productive (Hood, 1991, p. 16).

One of the tools employed by governments to increase this productivity is through the development of competitive funding systems, for example the Research Assessment Exercises (RAE, no date), these being held in the UK since 1986 and being replaced by the Research Excellence Framework (REF) in 2014. Compared with the RAE was new in the REF the introduction of the assessment of impact via the use of citation information in the assessment: "The assessment of impact will be based on expert review of case studies submitted by higher education institutions" (REF, 2011).

Here, the emergence of competitive funding systems also brought about an assessment of the competitive advantage of universities in the interest of the assessors and assessed alike. When universities are first and foremost viewed as corporate enterprises (Jarratt, 1985), an investigation into the performance assessment of universities should initially consider what lessons there are to be learned from the corporate sector where performance measurement practices have existed for much longer. Clearly, this view is nothing new but is still not widespread in higher education, as indicated in the following quote: "until very recent economists have … treated the university as sacrosanct and have spent their energies looking out through its windows at the rest of the world instead of viewing their own natural habitat" (Cartter, 1965, pp. 481-482). That this situation has not changed since emerges from the following recent quote: "Although PMS are used and accepted in organisations across the globe, institutions of higher education are just beginning to embrace the need of such assessment" (Smulowitz, 2015, p. 70). This among the many other reasons which will be discussed later in the thesis makes the present research an important work as an addition to the existing knowledge concerning performance measurement, especially performance measurement in higher education.

1.2 The Research Context

An example of the enormous impact of governmental research funding can be seen in the origin of Google. This can be linked to support by the United States' National Science Foundation to one of Google's founders, Sergey Brin, and a $4.5 million digital library initiative grant to Stanford, which helped the development of early prototypes of the search engine (Lane, 2009, p. 1273).

Hakala and Nieminen (2002, p. 5) maintain that the funding of academic research generally aims to reach one or more of the following goals: to selectively support areas of academic research and to bring together research capacity; to reach or maintain an international front position in certain areas of research competence; to respond to knowledge needs in society and provide scientific knowledge on nationally important issues.

The results of an evaluation of the impact of a number of research funding programs in Finland in the late 1990s by Hakala and Nieminen (2002, p. 13) identified activities that, to some extent, increased by the participation in these programs, such as doctoral training, international publishing, collaboration among different disciplines, international research collaboration, collaboration between different organisations and the combining of basic and applied research.

According to Lindsey (1991, p. 222) the performance of public universities is strongly associated with the absolute level and size of (state) funding, and that funding decisions are often guided by the reputation of the university or researcher, so leading to the ‘rich’ become ‘richer’ – an effect known as the *Matthew effect*[2].

Here, the functional specialisation of researchers’ approaches to performance measurement in higher education emerges from the literature and shows great variation in the extent and methods of evaluation of academic research. Traditionally, academic performance is measured according to its article and citation count and/or assessment by a peer review (Abramo, D’Angelo and Caprasecca, 2009, p. 206). However, these measurements have little non-academic benefit for directed (corporate) sponsors (Bessette, 2003, p. 356). On the contrary, standard economic models for example the Return On Investment (ROI) model, linking input and output, fail to do justice to the impact of investment on science. To date, however, relatively few universities have the tools or experience to strategically assess and upgrade their research performance through output, citation and/or trend evaluation or hypothetical modelling (Korhonen et al., 2001, p. 121)

The developments in capturing research performance in measurable values are the subject of an ongoing debate, especially in the bibliometric literature. Moreover, the topics that emerge in the next section of this chapter are but a sample of those that contribute to the potential richness of the research field.

The present research focuses on the models, theories and *best practices* found in the management literature which enable university decision makers to better understand, plan and execute their research strategies. The current study also draws on the extant literature about research assessment in higher education. It further focuses on Germany and makes specific reference to the higher education sector that exists within that country. The development of this research stems from a personal desire to explore how current research

[2] The *Matthew effect* is used as explanation for the often disproportional amount of credit already famous universities or scientists obtain and of the disproportional allocation of scientific resources these famous universities or scientists experience (Merton, 1988, pp. 607-608, see further section 1.3.3 of this chapter).

assessments practices can be improved by introducing learning from other domains than that of the higher education sector.

In sum, this preliminary review of prior research suggests that the *measuring* of research performance is undertaken with the aim of *improving* key aspects of research performance, including the *publishing* of research outputs and *collaboration*. However, few universities appear to have the tools and/or the experience to scientifically measure performance. In particular, capturing the construct *research performance* in measurable values appears to be a topic of on-going debate; this thesis does not set out to resolve all the issues relating to the measurement of university research performance. Despite these caveats, it is expected that by drawing on the experiences of the corporate sector where performance measurement has a much longer history this will yield a significant contribution to the knowledge of performance measurement in the higher education sector.

As will be highlighted in the next chapter, reviewing the context of performance measurement in both the corporate sector and the higher education sector up to the present time and in much more detail than is indicated here, makes it possible in this investigation to bring together the *best practices* from different research domains, including bibliometry and corporate management research. Hence, the scale and complexity connected to the research topic is a fundamental concern in this thesis. Nevertheless, this is not to say that complex questions should be left unchallenged. The following sections of the chapter present the *Background to the Research* section and the *Outline of the Research* section; in the latter section, the questions of real interest are asked.

1.3 Background to the Research

The assessment of research performance is a research topic offering a multitude of interlocking perspectives, including perspectives which are bibliometric, financial, organisational/managerial, ethical, and many more. The aim of the following sub-sections is to provide an early but brief understanding of the organisational context in which performance measurement takes place, the prevailing methodological approaches and established theoretical frameworks.

1.3.1 The Organisational Context

In a reflection on a broad level of the interests of governments when making contributions to higher education, Lindsey (1991, p. 230) presents the example of the State of California with an economy which is highly competitive and technology driven that needs a solid and high quality scientific and technological infrastructure as provided by research universities. Moreover, he sees the belief of governments in the value of such an infrastructure for economic development at least partially reflected in the investments governments make in such an infrastructure.

A study into the effect of funding on the performance of Flemish universities in the 1980’s and early 1990’s found that during the 1980’s significant changes took place in the funding structure of scientific research conducted at universities, particularly in Western Europe. This is evident in the following quote: “Generally speaking, during the 1980’s funds for scientific research were allocated more and more on the basis of competitiveness” (Moed et. al., 1998, pp. 231-232).

The fact that funding is becoming increasingly competitive is also seen by Hakala and Nieminen (2002, p. 1) as one of two recognisable international ‘mega-trends’ when examining public funding policies in the 1990’s. The second trend is that research funding has becomes targeted for specific purposes. The increased orientation of governments on competitive funding mechanisms and on output can be explained by the government’s role in the ‘principal-agent dilemma’ as emerging in the context of New Public Management (NMP[3]).

[3] The doctrines of New Public Management (NMP) comprise seven overlapping precepts including explicit standards and measures of performance, greater emphasis on output controls, a shift to greater competition in the public sector and stress on private sector styles of management practice (Hood, 1991, pp. 3-19).

> *The 'principle-agent dilemma' reflects a situation in which the government or a governmental agency is attempting to enhance its own or wider societal targets, for instance, via public research funding programs. As it does not have the appropriate know-how and human resources to conduct the mission, it needs to "delegate" the actual implementation of tasks* [= research] *to specialised organisations such as universities.*

(Auranen and Nieminen, 2010, p. 823).

The wider societal targets of *outsourcing* the establishment of a scientific infrastructure to universities by governments may differ from country to country and can be framed in *Olsen's four state* model (Olsen, 1988, pp. 236-242). This includes: the Sovereign, Rationality-Bounded state, the Institutional state, the Corporate-Pluralist state and the Supermarket state. In the Sovereign state model, higher education is seen as an instrument to implement any political objectives and universities are assessed based on their political effectiveness. Australia has a strong orientation towards this model although a positive influence on publication productivity cannot be found (Himanen et. al., 2009, pp. 421). In the Institutional state model, the university's responsibility is to protect academic freedom against shifting political regimes, coalitions and the short-term agendas of interest groups – here the government does not interfere with higher education. An assessment of universities is based on their effects on the structure of meanings and norms, and the Institutional state model emphasises the independence of the university from the state. An example of the Institutional model is the Dutch higher education system. The latter shows a constant increase in both publication output and citation impact despite the fact that research expenditure has hardly grown since 1991 (Himanen et. al., 2009, p. 421, and 428-429). Here, in the Corporate-Pluralist model, the 'Ministry of Education' is just one of many stakeholders, such as student and staff unions, professional associations, industry or regional authorities. Assessment of universities is based on the criteria of multiple stakeholders. Using this model is seen as a strength in the successful implementation of reforms resulting in improved scientific productivity in Norway (Himanen et. al., 2009, pp. 421 and 428-429). In the Supermarket model, the role of universities to deliver services, such as teaching and research, whereas the role of the state is minimal. An assessment of universities is based on criteria such as efficiency, economy, flexibility and survival. The United Kingdom’s strong orientation towards this model has proved to be unsuccessful and even harmful to the productivity of publications (Himanen et. al., 2009, pp. 421 and 428-429). Meanwhile, a scattered orientation towards all four models but adherence to none in particular can be found in Finland, while strong orientation towards this model has been shown to be unsuccessful and even harmful to the productivity of publications (Himanen et. al., 2009, pp. 428-429). In short, it can be concluded that increased performance is driven by permitting academic freedom and the demands of many stakeholders.

In the European Union there is the important role of performance evaluation and quality assurance formalised in 1999 by the Bologna Declaration (European Ministers for Higher Education, 1999). In this case, all universities in Europe are faced with the necessity of introducing mechanisms for quality assurance, with the consequent emergence of a plethora of evaluation systems.

Here, the introduction of performance measurement has had an impact on organisational behaviour as well as that of the individual researcher. Broadbent (2010, p. 18) observes that some institutions seeking to maximise their research income via good assessment scores are anxious to employ researchers and willing to reward those individuals who are likely to maximise the scores. Additionally, early career researchers prefer to undertake research that provides results sooner. Broadbent (2010, p. 23) concludes that research assessment has proved to be a powerful management control tool within higher education.

The fact that the results of research assessment can change any U.K. university’s financial position substantially for a five or six-year period and forces universities to concentrate primarily on their financial viability and growth, are just two of many reasons why universities set very specific targets as regards a university’s research achievements. Researchers maintain that for this purpose many higher education institutes resort to total quality management (TQM) to make their organisations ‘leaner and meaner’ and performance indicators are used to measure the various aspects of quality. However, they also observe, that “ ... some of the performance indicators used seem to have no connection with quality” (Tambi et al., 2008, p. 1005).

Another organisational impact of performance assessments is the effect on the determination of strategic objectives and the development of strategies to achieve these strategic objectives. For example, decision makers at the University of Warwick use the outcomes to enhance their learning about the strengths and weaknesses of their institution, to identify their sources of competitive advantage and areas for improvement (Tapinos et al.,2005, p. 196).

In sum, emerging from the literature referred to in this section of the chapter is that governments fund universities because their technology-driven economies require a technological infrastructure. The employment by governments of competitive and targeted funding systems to *control* the use of their funds can be explained by the paradigm of the *principal-agent dilemma.* Universities have responded to the performance evaluation by the government among others with the introduction of Total Quality Management (TQM) from which emerged that it is difficulty to connecting indicators for the concept quality. Within the context of the relationship between *funder* and *funded* is performance influenced by academic freedom of the *funded* and the demands of many stakeholders (=the funders).

1.3.2 Methodological Approaches

The archetype of an explicit and formalised assessment of the quality of research was the first Research Assessment Exercise (RAE) of 1986 which was undertaken by the Higher Education Funding Council for England (HEFCE). Further exercises were then held in 1989, 1992, 1996, 2001 and 2008. The RAE is the principal means by which institutions assure themselves of the quality of the research undertaken in the higher education sector in the U.K. However, this has now been replaced by the first Research Excellence Framework (REF) which was completed in 2014. Worldwide an increasing interest in quality and standards can be observed. A two-stage approach based on internal self-evaluation and external peer-review appears to be the widely and commonly accepted scheme (Barnabe and Riccaboni, 2007, p. 303).

RAE assessment is based on the peer assessment of the quality of research output in the format of journal articles, books and book chapters, an assessment of the research environment as well as one of the esteem of individual researchers who have been submitted to the exercise. Peer review is undertaken at the level of a ‘Unit of Assessment’ (UoA), which covers the research in a particular area, and is carried out by a panel of academics chosen by HEFCE following an open advertisement for the job. Each university can decide which UoAs they wish to submit and which researchers should be included. The grading of the ‘research environment’ and ‘individual esteem’ is conducted by two people, and is then followed by a group debate. The rating of all three elements is then aggregated into a single profile. The assessment process “provide[s] the basis for the allocation of resources but do[es] not consider what that allocation will be [this is HEFCE’s role]” (Broadbent, 2010, p. 18).

Here, the high costs and time commitment of peer evaluation has emerged as a key weakness of the RAE which has led to the suggestion to substitute peer evaluation for the use of bibliometrics (Oppenheim, 1995 and 1997) so offering challenging opportunities for academic libraries and publishers of bibliographic data.

By the late 2000s Italy, the Netherlands, Australia and New Zealand have introduced RAE-analogous exercises (Abramo et al., 2009, p. 206) as also have Hong Kong and Spain (Broadbent, 2010, p. 14). Moreover, the first integrated assessment of a whole university in Italy was carried out by the University of Sienna in the period 2001-2004, this being the VAI Project: Evaluation of University’s Institutional Activities – Teaching and Research. Here, the presence of external assessors was experienced as a fundamental positive element as was the existence of a link between the outcomes of the assessment and funding. However, among the weaknesses featured were the considerable financial and time commitments of the project. In an evaluation of this project in 2007, it was concluded that “… universities – at least in Italy – still have a long way to go before they will be able to fully implement and utilize performance evaluation systems…” (Barnabè and Riccaboni, 2007, pp. 302 and 316).

In short, it can be concluded that there is a world-wide interest in standards to assess research whereby the combination of internal self-evaluation and external peer review, analogous to the RAE's in the UK, is the commonly accepted scheme. However, the emerging weakness of the high cost as well as the time commitments of a peer review have initiated a discourse about the replacement of the peer review by bibliometrics.

1.3.3 Theoretical Framing

The history of accounting performance, the traditional backbone of quantitative approaches to organisational performance measurement, can be traced back to the genesis of double-entry bookkeeping in the thirteenth century by Venetian monks (Neely, 2007, p. 144). The three aims of accounting performance using financial measures are intended: (1) to serve as a tool for the efficient provision and use of financial resources to support the strategic goals of the organisation; (2) to signify the achievement of key business objectives; (3) to serve as an instrument for motivation and control (Neely, 2007, p. 12).

Cost accounting systems based on the company's double-entry bookkeeping system were provided in the first half of the nineteenth century for managers of large enterprises, for example in textile mills and railroads, so providing them with the means to monitor the efficiency of their operations. In the second half of the nineteenth century, these approaches further developed into systems providing operating statistics for the evaluation and control of the company's performance, these being "… very similar to those that would be used 100 years later to monitor the performance of revenue centers in the firm" (Kaplan, 1984, p. 392).

The single most powerful tool developed by 1910 is the DuPont Pyramid of financial ratios which defined the Return on investment (ROI) as the ratio of net profit to capital employed. This measure has served since then as the most basic indicator of the efficiency of company departments and a measure of the financial performance of the company as a whole (Kaplan, 1984, p. 397). The development of the ROI was preceded at the turn of the twentieth century by the development of the archetype of all modern performance measurement systems - the French Tableau de Bord. The aim of this approach is to improve production by bringing about a better understanding of the cause-effect relationships between process engineers actions and process performance. The Tableau de Bord supports managers' decision making by providing a succinct overview of few key parameters, thereby avoiding information overflow. The Balanced scorecard (Kaplan and Norton, 1996), the latest key development in performance measurement frameworks, encompasses many of the Tableau de Bord's features at a conceptual level but it surpasses the Tableau de Bord in the emphasis given to non-financial indicators (Epstein and Manzoni, 1997, pp. 29 and 36).

Interestingly, these performance measurement practices are not inventions of the business world but of the educational world. The beginning of the quantitative marking of students' results in the 1760's provided institutions with a means with which to prove that their candidates were the best and this allowed institutions to set targets (Strathern, 1997, p. 118). Later, in the 1880's businesses learnt their human accounting from the educational world by combining financial and human performance (Hoskin and Macve, 2000, p. 40). However, by the end of the twentieth century these accountancy practices of the business world looped back, in a somewhat altered form, into the educational world. This process by which values transfer in altered form from one domain to another and transfer back again is known in anthropological literature as *Cultural replication* (Strathern, 1997, p. 119).

The implicit or explicit theoretical assumption in the relationship between funding and research performance is that dependence on external resources forces researchers and universities to modify their activity as conditions for funding change (Auranen and Nieminen, 2010, p. 823). Moreover, it has been found that the relationship between funding and performance encompasses more dimensions than that of funding level; size also impacts on the variations of quality and success, while autonomy levels are assumed not to impact (Lindsey, 1991, p. 225). Auranen and Nieminen (2010, p. 824) used a two-dimensional framework (x-axis=*Orientation of core funding devoted to research* and y-axis=*Share of external funding for research*) to analyse whether more competitive funding environments are more efficient and result in increased publication output. Within this framework, funding systems in countries can be positioned according to their input or output orientation and a small or large share of external funding. The authors' assumptions are that the position of each country's funding system within this framework mirrors the potential receptiveness of universities to different steering impulses. The funding per publication ratio, the means of publications and funding for a six-year period, were used to identify the effectiveness of universities positioned in the same quadrants of the framework. Nevertheless that the outcomes of this examination suggested that competition for funding makes universities more productive suggest several other observations that the relationship between competition for funding and publication output is more complex, for example because nearly all countries in this study introduced their funding systems at different times during the period of the analysis and efficiency ratios remained unchanged over time. Additionally, while countries with a more competitive funding environment such as the U.K., Australia and Finland seem more efficient, it was also the case that these countries had not been able to increase their efficiency in publication output (Auranen and Nieminen, 2010, p. 830).

Major limitations of the measure ROI-ratio to capture and express performance in academic research emerged from a study aiming to substitute costly and time- consuming peer review with quantitative measures of performance. Here, the ROI of investments in academic research are calculated using the following model:

ROI in science = university investment base budget[4]/(production x $100,000[5])

The results of this study indicate a strong association between the level of funding (funding in US$ per student) and the production of publications, yet a relationship between absolute and relative performance (ROI) could not be proved; the university with the second highest research output, UCLA, showed the lowest ROI. This result does not suggest that the funding of UCLA-research

[4] University investment base budget = total state funds base budget – university instructional base budget (=FTE enrolment x $3,000)

[5] multiplying the production count by $100,000 allows the determination of publications produced by $100,000 invested.

was a poor investment, but might be explained by the existence of a point of diminishing returns when further funding showed a plateau in the cost curve (Lindsey, 1991, p.232). In his reflection on the ROI model used, Lindsey maintains (1991, p. 232) that other returns on investment in academic research apart from publication output should be taken into consideration.

The *Matthew effect* describes patterns of misallocations of recognition for scientific work by which "… eminent scientists get disproportionately great credit for their contributions to science while relatively unknown ones tend to get disproportionately little for their occasionally comparable contributions" (Merton, 1988, pp. 607-608). This is used as an explanation for the often disproportionate amount of credit which famous scientists have already received and for the disproportionate allocation of scientific resources such famous scientists' experience. The *Matthew effect* has also emerged from an investigation into the relationship between the funding allocations and research performance of universities in Flanders. Here, the results showed that the externally funded research capacity was unevenly distributed among departments - 8% of the departments included in this study accounted for 50% of all the externally funded research capacity (Moed et.al., 1998, p. 239). The results of the Moed-study further indicate a clear relation between the international reputation of research departments, their leading scientists and the level of external funding.

Lane (2009, p. 1275) maintains that it is unlikely that a solely economic value based model does full justice to the long-term impact of investments in science. Economic values included in these economic value based models and related to investments in science comprise economic growth, job creation and increased productivity. However, such economic value based models do not include immediate or intangible outputs of investments in science such as new knowledge and technologies.

Moreover, deeper insights into the impact of investments can be gained by using a production function framework, but it will remain difficult to expand such a model for value creation in the knowledge economy because innovation in this domain is non-linear and involves the interrelationships of human beings, social structures and processes (Lane, 2009, p. 1274). It should also be noted here that the impact of investments in science may take many years or even decades to fully emerge; in agriculture, recent productivity growth is based on research investments made in the 1800s, the commercialisation of biotechnology is based on scientific findings in the 1950s and the Internet revolution is based on scientific investments in the 1970s and 1980s (Lane, 2009, p. 1275).

From the bibliographic review of the performance measurement literature it has emerged that the literature is published in a large number of sources and includes a large amount of rarely cited papers. This indicates a “relative immature field of academic study which has relatively little consensus about its core theoretical foundations” (Neely, 2005, p. 1267).

Put succinctly, this sub-section of the chapter shows the closeness of accounting performance with corporate accounting practices and that the archetypes of performance measurement frameworks and measures used in these frameworks were developed at the turn into the twentieth century and have not changed fundamentally since. This sub-section also demonstrates how accounting performance practices in higher education have developed in closeness to neoliberalism in the 1980s by which relationships between performance and funding, size, autonomy, level of competition and reputation have emerged.

Within the framework of the presented organisational context, the methodological approaches and theoretical frameworks, are the intentions of the present research to contribute to existing knowledge by identifying the key measurements of competitive advantage in academic research and to develop an understanding of the dynamic process through which performance in higher education is created and upgrades. An outline of the present research is presented in the next section of the chapter.

1.4 Outline of the Research

As introduced in *The Research Context* section of this introductory chapter, a plethora of questions may have relevance to this thesis and allow for the richness of exploration. The research therefore includes the following considerations:

- How important is performance evaluation in higher education?
- What knowledge gaps can be recognised with regard to performance evaluation in higher education?
- What issues have emerged from performance measurement implementations in higher education?
- How has corporate performance measurement developed over time?
- What 'best practices' in corporate performance measurement are applicable in higher education?
- What established management theories help to understand competitiveness in higher education?
- What parallel developments/differences can be recognised between performance measurement in the corporate sector and in the higher education sector?
- Which determinants impact research performance most?
- Does a better understanding of the creation and development of competitive advantage in research help universities assess and plan their research strategy better so that their goals will be more adequately met?

Because of the large number of questions that could be posed, also a large degree of extracting the key question and focus is required to lead to the research question to be answered in the present study:

> *Can we employ a broad framework, well embedded in the management literature, that explains the impact of the determinants on university competitive advantage generated by research and helps to understand the dynamic process by which university competitive advantage generated by research is created and upgrading is enabled so that*

university policy makers' strategic objectives can be more effectively met?

At its broadest level, this thesis is concerned with measuring performance. The main objective to do this is *to improve* performance, for example, through a better understanding of the relationships between the actions taken and process outcomes, or to monitor performance and compare this to the strategic goals and then take corrective action when required (Epstein and Manzoni, 1997, p. 29). The objectives of university decision makers are on the whole congruent with those of corporate managers, whereas the aim of university governmental funders is to secure the achievement of their societal targets by *outsourcing* education and research to universities, the objectives of the government are to employ performance measurement and develop competitive funding to make university systems efficient and more productive (Auranen and Nieminen, 2010, p. 822). These objectives offer challenging opportunities for the present research which must be explored to further advance extant knowledge.

The most common measure in corporate performance measurement systems is the Return on Investment (ROI) ratio. The ubiquitous presence of the ROI measure is explained because it is a globally accepted uniform metric (Eccles, 1991, p. 136). In higher education, the most common measures are: a publication count as a measure of the *production* of science, and a citations count as a measure of the *qualit*y of the science (Lindsey, 1991, p. 225). However, the uniformity of these and related measures is subject to a continuous debate concerning global standards that enable institutional benchmarking and cover the entire spectrum of research activities (Snowball metrics, no date). The most common method to assess performance in higher education is qualitative peer review. Nevertheless, this method is very costly as well as time-consuming and has initiated an ongoing a discourse concerning alternative quantitative methods (Oppenheim, 1995 and 1997). These developments, together with the knowledge that performance measurement frameworks that have been developed in the corporate sector are still alien to the higher education sector, have indicated the direction of the present research in an attempt to find the 'best practices' from the management literature and, when required, to adapt these for use in higher education.

Two research gaps, which are presented in more detail in the next chapter, have emerged from the performance measurement literature: (1) the difficulty in finding the right measures; (2) understanding the cause-effect relationships between actions and performance. The performance measurement literature as discussed in Chapter 2 of this thesis narrates the development of first the single criterion, this being followed by multiple criteria and later by composite criteria. However, it also highlights how the relationship between these quantitative measures and performance is often doubtful (Neely et al., 1995, pp. 80-116) or leads to dysfunctional consequences (Ridgeway, 1956, pp. 247). The present research will therefore focus on finding a broad framework, well embedded in the management literature, which helps to develop an improved understanding of the key determinants of academic research, to comprehend how competitive advantage in academic research is created and how its upgrading is brought about.

This study concerns the assessment of academic research, with a focus on the examination of a number of attributes of academic research and on the relationship of these attributes with research performance. Additionally, although it is valuable to consider the performance of developing young people and this clearly contributes to the quality of a university, the provision of instruction to students on a campus is not taken in consideration in the present research.

This study focuses on Germany, a focus which has been developed over the last decade by the author when working for the world's largest academic publisher in that country. More recent experiences with providing bibliographic tools for research assessment to university decision makers have initiated a consciousness that there is a lack of evaluation methods as well as the tools and experience with which to assess research performance properly (Barnabe and Riccaboni, 2007, p. 307). This may be caused by inhibition concerning the pursuit of management practices in higher education (Maynard, 1971, p. 2). The aim of the present research is therefore to initiate a situation whereby more academic decision makers will benefit from experiences gained outside their academic domain.

Within the context of the ongoing debate about the substitution of qualitative peer review by quantitative (bibliometric) measures, the REF, the successor of the RAE, concluded that “bibliometrics are not sufficiently mature to be used formulaically as a sole indicator or to replace expert review, but there is considerable scope for citation indicators to inform and supplement expert review of outputs in the REF, in certain UoAs” (HEFCE, 2009, p. 14). With the aim of adhering to a qualitative approach as in the RAE/REF but also to explore a quantitative approach as found in the corporate and bibliometrics literature, the present research will therefore pursue a *mixed method approach* integrating quantitative and qualitative methods in a single project. The purpose of this approach is for both methods to be mutually illuminating (Bryman, 2012, p. 628).

The potential outcome of the present research is a theoretical framework that explains why a university achieves competitive advantage in all its forms, reflects the richness of the concept of competitiveness, helps to understand why some universities perform better than others and explains the environment in which universities compete and strive to upgrade their performance.

1.5 Contribution to Scientific Knowledge

The ultimate aim of the present research is to make a contribution to existing scientific knowledge. Within the context of this aim adheres this study to the following definition of knowledge:

> *Knowledge comes as the result of a purposeful and systematic process aimed at bringing new understanding through the development and testing of new theories.*

Morrison, 2003.

The relationship between the contribution to scientific knowledge and professional practice is explained in the following quote from Peter Drucker:

> *Knowledge is information that changes something or somebody – either by becoming grounds for actions or by making an individual (or an institution) capable of different or more effective action.*

Peter Drucker, no year, as cited in Morrison, 2003.

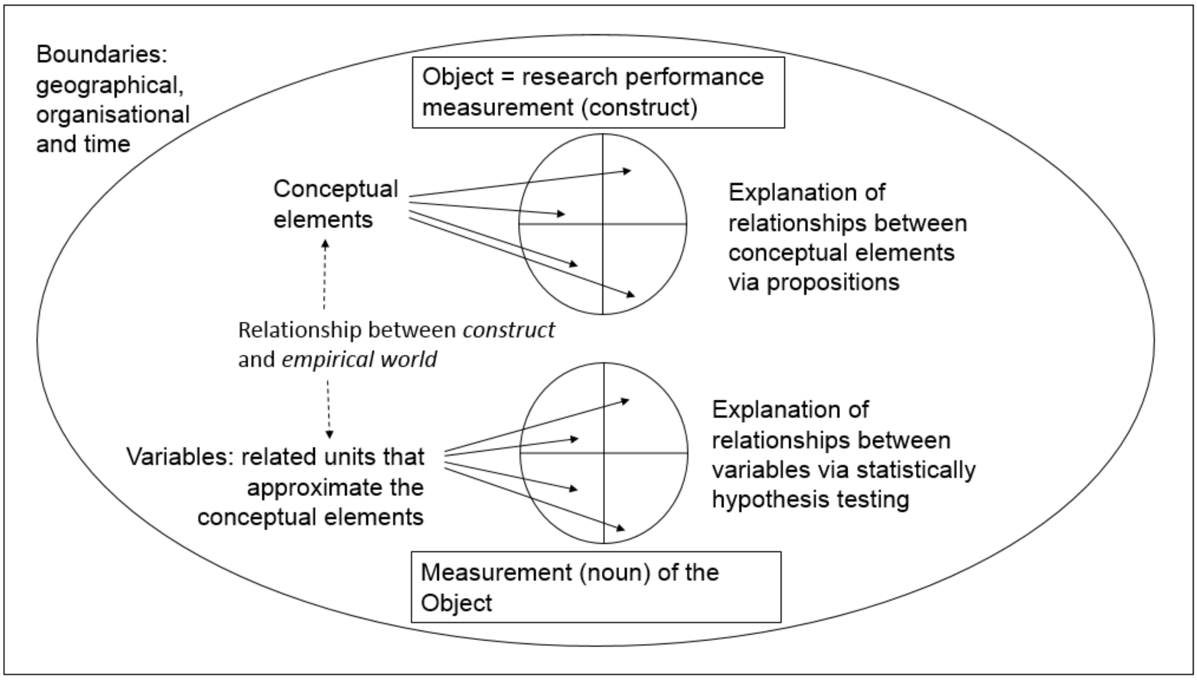
Drawing on these definitions is the contribution to knowledge of the present research articulated in the research question by the following wording *"… explains the impact of the determinants on university competitive advantage generated by research and helps to understand the dynamic process by which university competitive advantage generated by research is created and upgrading is enabled".*

The aim of "*making an individual (or an institution) capable of different or more effective action"* is also articulated in the research question: "…*so that university policy makers' strategic objectives can be more effectively met".* This however implies for the researcher that the contribution to scientific knowledge by this thesis should be useful, or in other words: should both explain and predict. For this purpose this study aims to provide explanation via logical reasoning of underlying theories and to provide predictions based on comparing the logic of existing theories with empirical evidence generated in the course of the research. In order to be useful seeks the contribution to scientific knowledge of this study compliance with the *Five criteria for knowledge to be of value* as formulated by Reynolds (2007, p. 6):

1. A method of organising and categorizing;
2. Predicting future events;
3. Explaining past events;
4. A sense of understanding about what causes events;
5. The potential for control of events.

A conceptual model of the intended contribution to knowledge by this study drawing on *modern measurement theory* is presented in Figure 1.

Figure 1: Conceptual model of the intended contribution to knowledge by this thesis drawing on modern measurement theory



Adapted from Morrison, 2003, p. 6.

As depicted in Figure 1 is the *object* of this study a *construct* which is created by grouping various conceptual elements which cannot be adequately measured by a single variable. The relationship between the *construct* and the *empirical world* will be explained in this study by statistically testing hypothesis related to the relationship between variables, and by putting forward propositions about relationships between more abstract concepts drawing on existing theory. The *variables* included in the figure can be defined, observed and directly measured in the empirical world. An explanation of why these variables have been selected and of their relevance for the present study present an important aspect to be addressed in this study. The boundaries of the present research are defined by geographical setting, organisation type and time period.

Drawing on the conceptual model in Figure 1 aspires the present study to add new knowledge by way of helping university decision makers in their efforts to understand how competitiveness generated by research develops and can be improved. This contribution should be in the form of an improved solution, this being an adaptation of an established theory which is well embedded in the (management) literature.

On a lower abstraction level the contribution to knowledge by this thesis will comprise new quantitative data revealing new insights into the condition of German universities with a focus on research, new qualitative data presenting a careful, detailed and structured account of the process of development of competitiveness generated by research, new support for an existing theory, the application of an existing model in an sector where it has (almost) never been used before.

1.6 Summary of the Aims, Objectives and Goals of the Present Study

This chapter established the context and significance of the present study and provided a number of aims, objectives and goals. These can be synthesized into five intended key contributions to scientific knowledge and professional practice, as shown in the following table.

Table 1: Table of intended key contributions in the present study

Summary of aims, objectives and goals as presented in Chapter 1	**Key contribution**
Create cross-fertilisation by bringing knowledge together from different areas of investigation.	Learn from different research domains and introduce this knowledge into the higher education domain.
Bring together the best practices from different research domains, including bibliometry and corporate management research.	
Find the best practices from the management literature and adapt these for use in higher education.	

Adhere to a qualitative approach as in the RAE/REF, but also exploit a quantitative approach as found in corporate and bibliometric literature.	
Help university decision-makers attain their strategic goals by improving their understanding of how university performance in research is created and develops.	Improve the understanding of how university performance in research is created and develops to improve the attainment of universities' strategic goals.
Develop an understanding of the dynamic process through which performance in higher education is created and upgrades.	
Help to understand the dynamic process by which university competitive advantage generated by research is created and upgrading is enabled so that university policy makers' strategic objectives can be more effectively met.	
Provide new qualitative data which presents: (1) a careful, detailed and structured account of the process of the development of competitiveness generated by research; (2) new support for an existing theory; (3) the justification for the application of an existing model in a new sector.	
Identify the key measurements of competitive advantage in academic research.	Identify the key measurements of university performance and explain their impact.
Explain why variables have been selected.	
Explain the impact of the determinants on university competitive advantage generated by research.	
Provide new quantitative data that brings new insights into the competitive condition of German universities.	

Employ a broad framework, well embedded in the management literature that explains the impact of the determinants on university competitive advantage generated by research.	Provide (a) theoretical framework(s) for university performance.
Provide a theoretical framework that: (1) explains why a university achieves competitive advantage in all its forms; (2) reflects the richness of the concept of competitiveness; (3) , helps to understand why some universities perform better than others; (4) explains the environment in which universities compete and strive to upgrade their performance.	
Contribute to scientific knowledge with a solution that: (1) provides a method of organising and categorising; (2) predicts future events; (3) explains past events; (4) provides an understanding about what causes events; (5) offers the potential to control events.	Make a contribution to professional practice with a practical solution for the research problem.
Provide an improved solution, this being an adaptation of an established theory which is well embedded in the (management) literature.	

1.7 Concluding Remarks

The following section of the chapter is a “roadmap” for the thesis.

Chapter 1 establishes the context and significance of the present research by presenting a preliminary review of the extant literature about the topic of this thesis. Through an examination of the current and emerging organisational, methodological and theoretical context of performance measurement a need for further research has been identified. This further research specifically relates to the applicability of ‘best practices’ from the economics and management literature in higher education, this being an under-researched area although it is deemed to offer important opportunities for organisational improvement.

Chapter 2 broadly elaborates on the context presented in Chapter 1 and provides a description, summary and critical evaluation of the extant literature in relation to the research problem. The aim of this chapter is to disclose any gaps in the literature, to identify any relevant previous studies which avoid the duplication of work, to give direction in fulfilling the need for additional research, and to locate the present research within the context of existing literature. For these purposes, the review of the literature focuses on the drivers of the development of evaluation systems, their objectives and impact on organisations, and on the development in methodological approaches with the aim of identifying seminal approaches and/or archetypes of frameworks. In conclusion, the development of this field of research is reviewed.

In Chapter 3, the research philosophy is presented together with the research design, the methodology employed and methods used to identify, select, and analyse the data and information used. This is done to answer the research question as well as to allow the reader to critically evaluate the validity and reliability of the present research. By choosing a mixed method approach, bringing together a quantitative and a qualitative approach in one single project, this chapter describes the ontological and epistemological orientation of each approach, this being followed by a description of the methodology, the methods used and the analytical methods employed. This research strategy includes the rationales for secondary data analysis and the semi-structured interview approach. The chapter is brought to a close with details surrounding the data collection and data analysis.

Chapter 4 provides the data and information to inform the discussion in the Chapters 5 and 6. The findings of the present research are presented in a logical sequence without bias or interpretation. Here, the quantitative sections of Chapter 4 contribute to methodological approaches by testing a number of hypotheses concerning the relationships between a number of institutional variables and performance. The quantitative data is analysed using standard statistical methods to test the relationships between the variables and performance; this has the purpose of establishing the competitive condition of the university. The qualitative sections of this chapter include narrative accounts from participants’ interviews. These participant accounts are analysed using *thematic analysis* (Braun and Clarke, 2006, p. 82) to capture important topics in the interview data in relation to the research question. Such qualitative sections predominantly contribute to professional practice by featuring the characteristics of each stage of the competitive development.

The aims of Chapter 5 and Chapter 6 are to interpret and describe the significance of the findings presented in Chapter 4 with the objective of elaborating on new understandings connected with the research problem. The discussions In Chapter 5 and Chapter 6 allow the reader to critically evaluate how the recent research has moved forward an understanding of the research problem.

Chapter 5 discusses and interprets the quantitative findings and explains why they are relevant to the research question, relating them to similar studies in Chapter 2 and exploring how the possible adaptations of extant frameworks can help to answer the research problem and fill existing gaps in the literature.

Chapter Six discusses and interprets the qualitative findings and explains why they bear relevance to the research question, relating them to similar studies presented in Chapter 2 and exploring how a more profound understanding of the process of the development of competitiveness in academic research can help to answer the research problem and fill existing gaps in the literature.

Chapter 7 reflects the aim of the present research, summarises the key contributions to professional practice, to methods and to theory, of each chapter, and synthesises the key points, so bringing about a new insight and creative solutions to answer the research question. The significance of the present research is then demonstrated by highlighting the implications for the theory, methods and professional practice. Here, the limitations of the present research are discussed and opportunities for future research are presented. The chapter comes to the conclusion that the evidence presented in this thesis is convincing and largely consistent with the extant literature; it also shows how the findings of the present research demonstrate that the presented solution is of a compelling simplicity and applicable to answer the research question, so enabling university decision makers achieve their strategic objectives more effectively.

The author is fully aware that the broad topic of the measurement of research performance is high on the agenda of governmental and university decision makers worldwide and that the scope of this thesis does not make it possible to answer all the relevant questions. The aim of this thesis is to contribute to knowledge by acquiring a deeper understanding of the key determinants of competitive advantage in academic research and of its origins; the thesis also aims to help decision makers achieve their strategic objectives better. This seems to be an appropriate justification for intellectual investment in an enquiry about the assessment of competitive advantage in the research of German universities and contributes to the field of performance evaluation research.

CHAPTER 2: REVIEW OF THE LITERATURE

2.1 Introduction

The aim of this chapter is to consider the intellectual progression of *performance measurement* as field of academic enquiry, in doing so emphasising developments in measurement frameworks and measures and changes in approach due to emerging imperfections or critiques on these and within the context of the sources consulted while exploring the research problem. The underlying objectives hereby include to demonstrate how the present research fits within a larger domain of study and to highlight how the reviewed literature informs the study's primary research.

The findings in this chapter are presented in the format of a *theoretical review* and examine the body of work that measures performance in both the corporate and the higher education sector. This format has been chosen since it establishes the theoretical framework of the research – identifying the key existing theories, the relationships between them and the degree to which previous research has investigated these theories. The purpose of this format is to determine any lack of appropriate theories – these being related to frameworks, measurements and approaches – and to reveal the possible inadequacies of existing theories in order to explain the present research problem.

The presentation of the findings in this chapter comprises a review of the works most pertinent for the study highlighting empirical findings and applied methods and a critical discussion of the key contributions to knowledge of the works presented. For this purpose is the evidence presented in the reviewed literature subjected to the following questions: (1) What are the key contributions to knowledge?; (2) How were they developed?; (3) What supporting assumptions are made?; (4) What is the theoretical base?; (5) Are the methods used trustworthy?; (6) Is there congruence/controversy with other studies? The critical discussion in this chapter concludes with putting forward a proposition to be maintained or adapted by the present research.

The objectives of this chapter are manifold: (1) to locate the present research within the extant literature; (2) to disclose the *core* of the debate; (3) to identify the key variables, the methodologies used and the operational approaches; (4) to identify the theoretical foundations included in the reviewed studies; (5) to disclose any gaps in the literature; (6) to avoid a duplication of effort; (7) to disclose any need and/or direction for additional research with the present study.

The review of the literature begins with a bibliometric analysis of the body of performance measurement literature, and is then divided into two main parts. The first part explores the performance measurement in the corporate sector literature and commences with a clear articulation of Porter’s thesis. Thereafter, alternatives of Porter’s models/approaches are provided and their appreciation is articulated. This stage of the literature review finishes by establishing the match between the most salient models/approaches and the objectives of this research, and concludes by clearly explaining why Porter’s models/approach has been chosen. The second section explores the performance measurement in higher education literature and is structured in a similar way to the review of the performance measurement in the corporate sector literature.

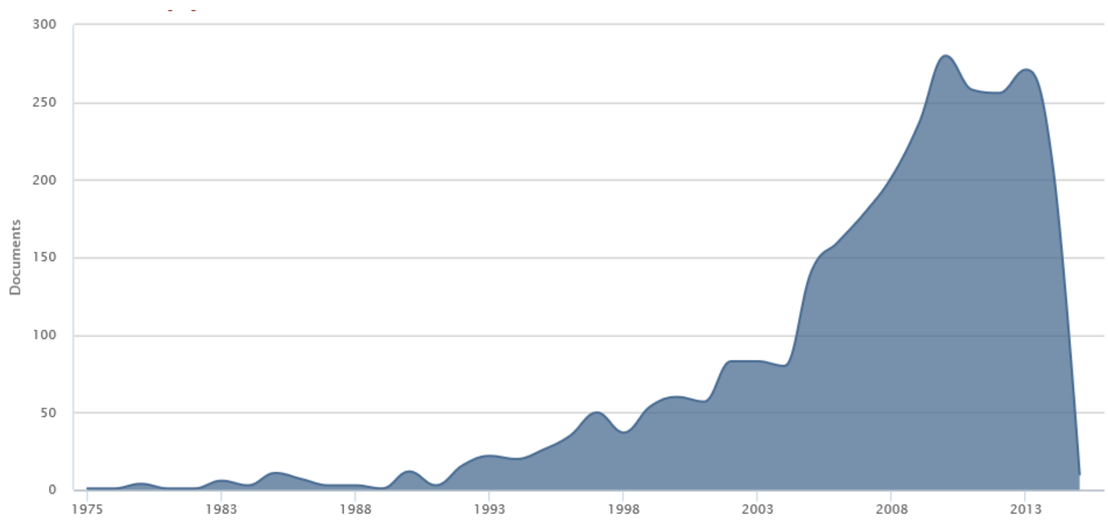
2.2 Bibliometric[6] Analysis of the Performance Measurement Literature

To establish that the written account of the performance measurement literature presented in this chapter is grounded in empirical evidence a bibliographic database was used to collect bibliometric data about the volume and development of the body of literature on performance measurement and to identify key publications for further analysis. The dataset was constructed by performing a *document search* for articles containing the phrase *performance measurement* in the article title, abstract or key word field and limited to the business, management and accounting literature using Elsevier's *Scopus*[7] (no date) abstract and citation database. The retrieved dataset included 2,882 papers published between 1975 and 2015 in a total of 160 different sources. Figure 2 shows the rapid increase in the number of peer reviewed articles per year in the retrieved dataset over the last 2½ decades. Significantly, coincides the beginning of the rapid increase in the annually published output with the publication of Kaplan and Norton's (1992) seminal paper on the Balanced Scorecard, this paper being cited 3,559 times since its publication.

[6] Bibliometrics = "the application of mathematics and statistical methods to books and other media of communication"(Pritchard, 1996, p. 349).

[7] Elsevier's Scopus database is the world's largest abstract and citation database of peer-reviewed literature and contains 55 million records from 22,000 titles published by 5,000 publishers worldwide.

Figure 2: Number of peer reviewed articles per year on the topic performance measurement



Scopus database, no date.

From the retrieved dataset in this study further emerged two substantive reviews of the performance measurement literature: Neely et al.'s "Performance measurement system design" (1995) and its update "The evolution of performance measurement research" (Neely, 2005). The relevance of the latter publication for the present study is that it highlights the lacking of a comprehensive theoretical framework /conceptual model. Neely (2005, p. 1267) holds that the large contribution to the body of literature of rarely cited works and the diversity of journals in which this material is published "...is indicative of a widely distributed and relatively immature field of academic study, which has relatively little consensus about its core theoretical foundations". Neely's finding of an abundance of rarely cited works published in a diversity of journals is congruent with the findings emerging from the dataset used in the present study. Therefore, the assessment of the performance measurement literature in this study aims particularly on the identification of models well embedded in the management literature.

2.3 Review of the Performance Measurement in the Corporate Sector Literature

In response to the reference in Section 2.2 to the (omission of) core theoretical foundations of performance measurement provides the following subsection of the chapter a brief review of the theoretical foundation of *measurement theory*. This review of the *measurement theory* is largely drawing on the substantive review of this topic by Pike and Roos (2007, pp. 218-235) in Neely's seminal book on Business Performance Measurement (Neely, 2007).

2.3.1 The Theoretical Foundation of Performance Measurement

The relevant theoretical foundation of performance measurement is to be found in *measurement theory*, belonging to the domain of applied mathematics.

The origins of *measurement theory* can be traced back to Eudoxus of Cnidus - born around 410 BC (Pike and Roos, 2007, p. 225). Eudoxus established what may have been the first deductive organization of mathematics on the basis of explicit axioms[8]. The change in focus by Eudoxus stimulated a divide in mathematics which lasted two thousand years. Modern theory of measurement emerged in the 19th century from the work of Helmholz and others on counting and measurement, whereas in the 20th century the need to understand what it means to measure things in social sciences drove the further formalisation of measurement theory in the 1900s (Pike and Roos, 2007, p. 225) and the publication in 1904 of the first textbook on *measurement theory* written by E.L. Thorndike: An introduction to the theory of mental and social measurements. Since then many books on this subject have followed until the 1950s, when "… most of the foundation for present-day measurement theory was completed" (Allen and Yen, 1979, pp. 3-4). Thereafter, modern measurement theorists have further developed the field and augmented and replaced measurement

[8] "Axiom = Statement or proposition on which an abstractly defined structure is based" (Stevenson and Waite, 2011, p. 92)

practices. Among them Krantz et al. who presented the main propositions of modern *measurement theory* including:

- *Numerical representations of quantities and laws of nature are determined by the set of axioms for corresponding empirical systems;*
- *These numerical representations are unique up to some sets of allowable transformations [= change of measurement units];*
- *All physical attributes may be embedded into the structure of physical quantities;*
- *The same axiomatic approach is also applicable not just for physical attributes and laws but for many other attributes from other domains.*

Krantz et al., 1971, 1989, 1990 as cited in Pike and Roos, 2007, pp. 225-226.

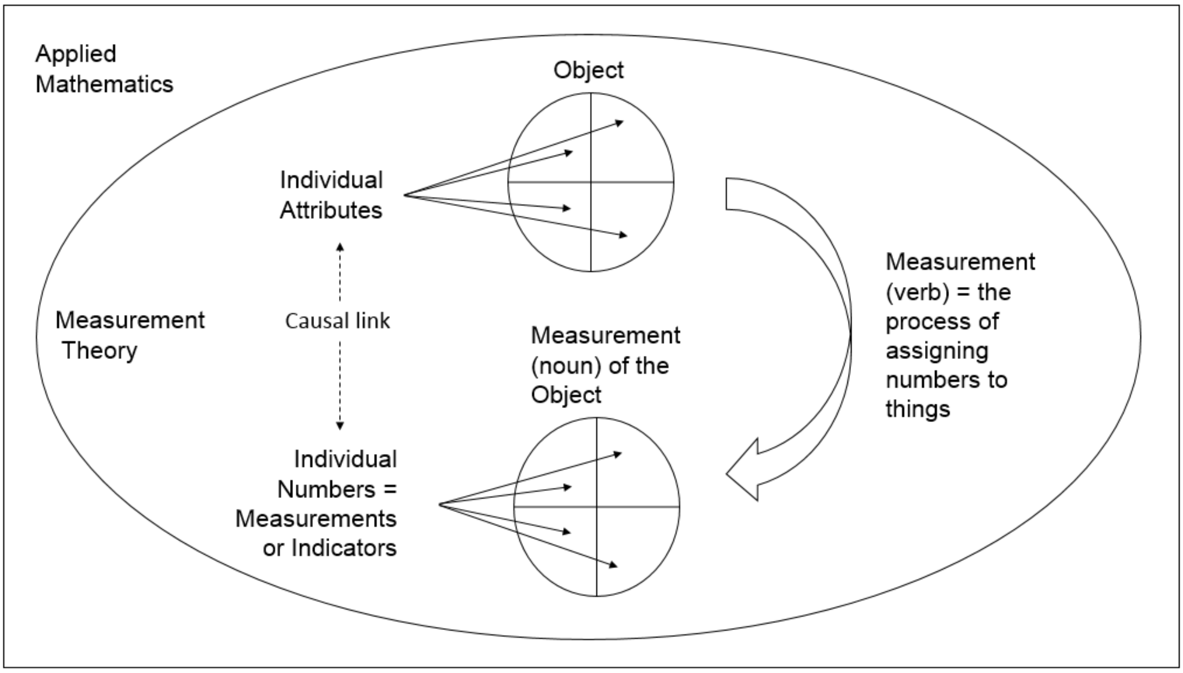
The contribution to knowledge by the review of the literature about the development of measurement theory especially relevant to this study is the notion that a *measurement (noun)* is a representation of the *object* being measured. Hereby is the nature of the relationship between the *attribute* and the *measurement* pivotal when drawing conclusions about the *object*. In addition, *measurement (verb)* is defined as:

> *The process of assigning numbers to things in such a way that the relationships of the numbers reflect the relationships of the attributes of the things being measured.*

Pike and Roos, 2007, p. 218.

The correspondence between *attributes* and *numbers* is further drawing on the rigour of the approach by which in less rigorous approaches *measurements* are termed *indicators.* Within this context is a *measure* a quantity that can be relatively unambiguously counted and is an *indicator* an *indirect measure* of a (complex) concept that is employed as though it were a *measure*. The performance measurement concept is depicted in Figure 3.

Figure 3: The performance measurement concept



Adapted from Neely, Gregory and Platts, 1995, p. 81.

When designing measurement frameworks it is essential that the attributes of the object to be measured include “all the attributes that any legitimate observer or stakeholder believes to constitute the entity to be measured” (Pike and Roos, 2007, p. 223). The omission of causal links between *measures* and *objects* being measured is recognised as a common mistake in business measurement systems.

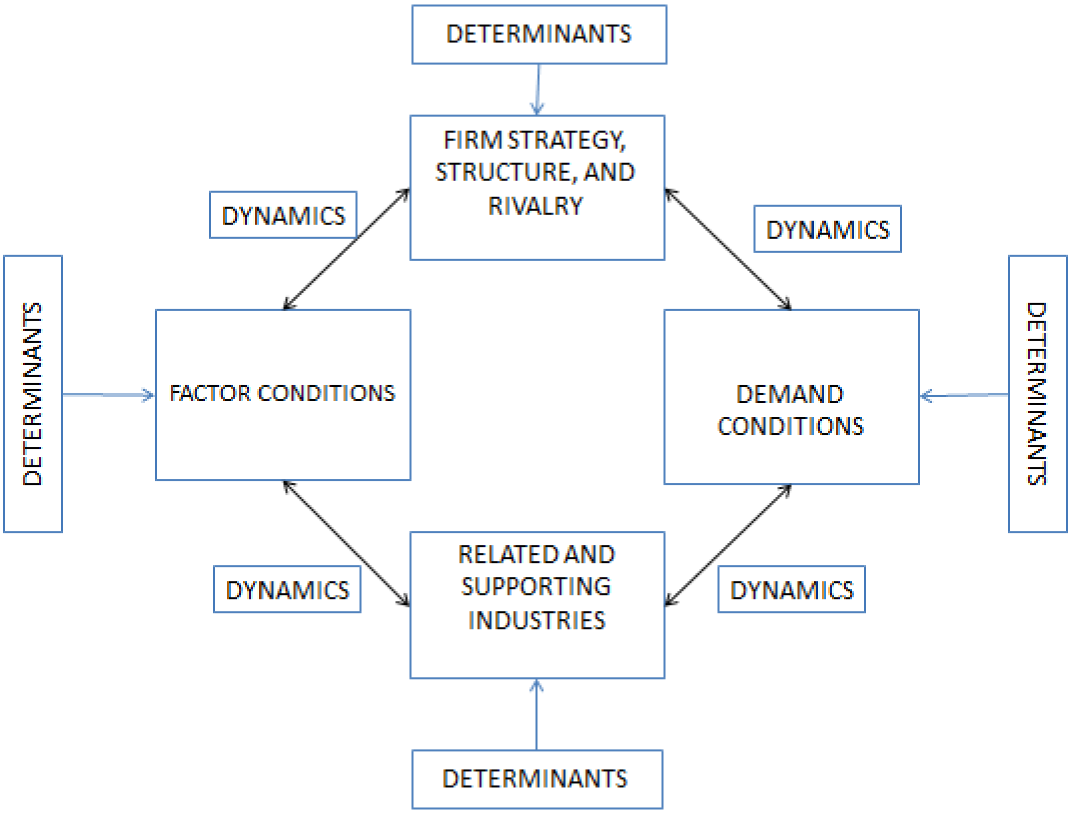
In conclusion, the relevance of this brief review of measurement theory for the present research is that it stresses how legitimate measurement systems should encompass all the relevant *attributes* of the *object* to be measured; the review also demonstrates how causal links must exist between the *attributes* of the *object* and the measurements/indicators.

2.3.2 Appreciation of Porter’s Models

What stands out in this immature field of academic study (Neely, 2005, p. 1267) is the work of one of the world’s “most popular scientists in the turbulent environment of strategy research" (Man, de, 1994, p. 449), namely Michael Porter's *The Competitive Advantage of Nations* (Porter, 1990). Since its publication, this work has triggered considerable interest not only in newspapers and magazines but also in academic literature - the latter including a Special Issue of *Management International Review* (1993, pp. 1-134) and being entirely devoted to Porter's thesis. Porter's work has been chosen to be placed at the heart of the review on the literature on performance measurement systems in the corporate sector. This is because Porter sees in it an explanation for "why … some social groups, economic institutions, and nations advance and prosper" (Porter, 1998, p. xxiii). This view is congruent with the objective of this study. An additional argument for the positioning of Porter's work is that it has "been incorporated as received truth into almost every undergraduate text on international business" (Davies and Ellis, 2000, p. 1190).

Porter's thesis argues that competitive advantage is determined by four broad groups of attributes: *Factor conditions; Demand conditions; Related and supporting industries*; *Firm strategy, structure and rivalry* - these are depicted as the corners of his diamond model. Development of competitive advantage involves passing through four successive stages, namely, the *factor-driven*, *investment-driven*, *innovation-driven* and the *wealth-driven* stage. Porter's five key assumptions are as follows: (1) to achieve the strongest competitive advantage the *innovation-driven* stage must be reached; (2) sustainable international success can only be based on more *Advanced Factors*; (3) competitive advantage is determined by the competitive condition of the home base; (4) to sustain strong competitive conditions, firms must operate in clusters of related firms with equally strong diamonds; (5) outward foreign direct investments are a determinant of competitive strength (Davies and Ellis, 2000, pp. 1192-1193). According to Porter the *determinants of advantage* in his diamond model "… individually and as a system, create the context in which a nation's firms are born and compete" (Porter, 1998, p. 71). In the corporate sector, these determinants comprise: (1) the resources and skills required to successfully compete in an industry; (2) the information necessary to recognise opportunities and to form the basis for decisions about the directions in which resources and skills are deployed; (3) the goals of managers and employees; (4) the pressures to invest and innovate which are exerted on firms. The determinants and the dynamics between the determinants govern the extent to which improvement and development of competitive advantage takes place as shown in Figure 4.

Figure 4: Porter's diamond model

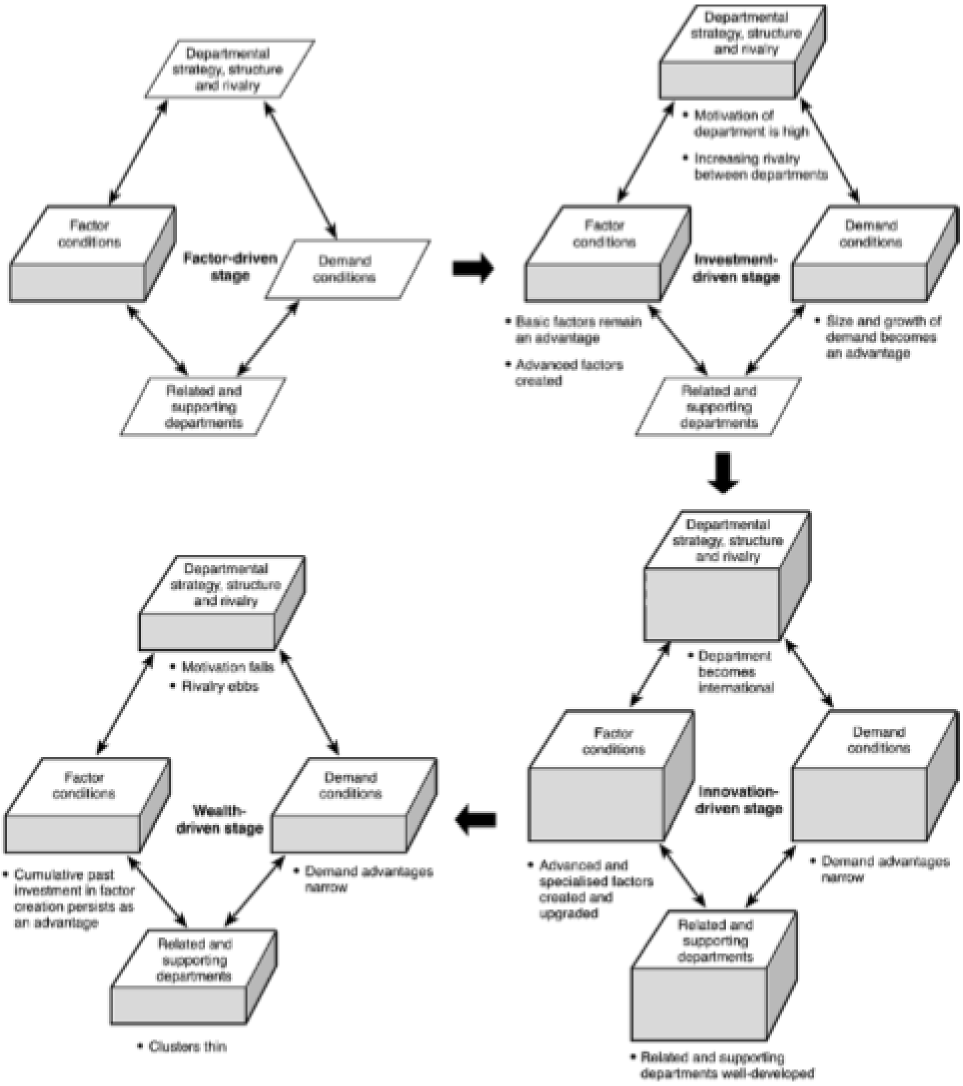


Porter, 1998, p. 173.

Porter highlights that innovation is the key to the upgrading of competitive advantage. Whereas Porter (1998, p. 175) does acknowledge that unpredictable chance events are important for the development of competitive advantage, does he however emphasise that it is the condition of the diamond which influences their impact on the development of the competitive condition.

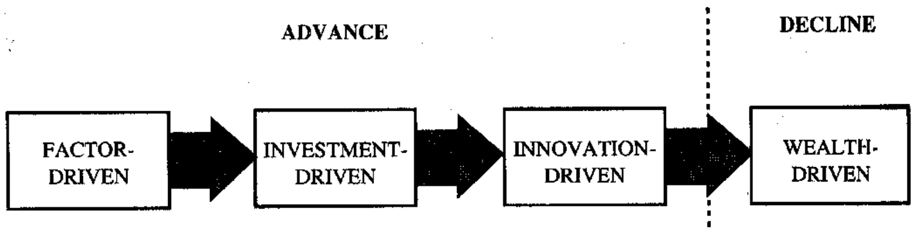
The condition of the diamond is further characteristic for the firm's stage of competitive development, as depicted in Figure 5 (this is further discussed in Chapter 6 of the thesis). Thus allows the diamond model to determine the stage of competitive development on the basis of few determinants while the model of competitive development as depicted in Figure 6 reflects the characteristic sources of advantage and the nature and extent of success (Porter, 1998, p. 545).

Figure 5: The condition of the diamond in the successive stages of competitive development



Curran, 2001, p. 247.

Figure 6: Porter’s four stages of competitive development model



Porter, 1998, p. 546.

Porter’s thesis is embedded in an abundance of concrete examples. These encompass a large number of industries and countries and have contributed to the argument for positioning his work at the heart of the literature review. However, despite the many plausible arguments in favour of Porter's thesis, it must be acknowledged that his thesis has generated extremely mixed reviews, these ranging from outright damnation to lavish praise - and often presenting a reflection of the authors' own backgrounds as well as the richness of their subject (Davies and Ellis, 2000, p. 1193). A review of the most salient criticisms is presented in the following subsections.

2.3.3 Critiques of Porter's Models

A plethora of published articles can be found in management literature critiquing or praising Porter's propositions. The purpose of the following subsections of the chapter is to review the criticisms of Porter's propositions in his *The Competitive Advantage of Nations* , the focus being placed on the most salient aspects of his research. These aspects include those conceptual foundations, theoretical foundations and empirical issues most relevant to answering the research question:

> *Can we employ a broad framework, well embedded in the management literature, that explains the impact of the determinants on university competitive advantage generated by research and helps to understand the dynamic process by which university competitive advantage generated by research is created and upgrading is enabled so that university policy makers' strategic objectives can be more effectively met?*

Particular focus will be on (1) the *competitive advantage* and the *comparative advantage theorems* ; (2) the location of true prosperity in the *Four stages of competitive development* model; (3) Porter's clustering theory vs. urbanisation economies; (4) the proposed extensions of Porter's diamond model.

2.3.4 Competitive Advantage and the Comparative Advantage Theorems

One of the most ambitious claims made by Porter in his *Competitive advantage of nations* is that this work puts forward a more dynamic explanation for international trade through the creation of a new *competitive advantage* paradigm. Central elements in this new paradigm are upgrading and innovation. This claim is criticised for not replacing “the simplistic precepts of classical and neo-classical microeconomics” (Magaziner, 1990, p. 189).

Porter’s claim to have introduced new elements to the international trade theory draws on his belief that “any new theory of national advantage in industries must start from premises that depart from much previous work” (Porter, 1998, p. 19). The claimed novelty of his *competitive advantage* paradigm is reflected by the challenges Porter set out to meet when he developed his thesis:

> *A new theory must start from the premise that competition is dynamic and evolving … must make improvement and innovation in methods and technology a central element … must explain the role of the nation in the innovation process … must also explain why the rate of … investments [in research, physical capital, and human resources] are more vigorous in some nations and not others.*

Porter, 1998, pp. 19-20.

Porter elucidates the need for a new explanation with two examples (Porter, 1998, p. 8) from the automobile industry. His first example highlights how the American automobile industry with a higher output per man hour than other American industries is experiencing a growing trade deficit because the level of productivity in the German and Japanese automobile industry is even higher. In his view, is an “… *absolute* productivity standard necessary to meet foreign rivals” (Porter, 1998, p. 8). The second example highlights how Korea is exporting cars to the US despite higher American *absolute* productivity in car production because Korea’s abundant labour force and low wages gives it an *comparative* advantage in the cars it exports. Porter concludes that “understanding why nations can or cannot compete in sophisticated industries and activities involving high productivity… [is]… central [in] understanding economic prosperity (Porter, 1998, p. 8).

The first example has been used by Porter's critics as evidence so show that Porter's explanation for the need for an *absolute* productivity advantage necessary to meet foreign rivals is not novel but rather draws on Adam Smith's (1776) *absolute advantage theory of international trade*:

> *This means that a nation produces and exports those commodities which it can produce more cheaply than other nations, and imports those which it cannot. A nation will not produce a good that is produced more expensively at home than abroad - be it a thirtieth, or even a three hundredth part more.*

Smith, 1776, cited in Schumacher, 2012, p. 62.

Adam Smith's *absolute advantage theory* explains differences in absolute production costs according to differences in *natural* advantages such as soil, climate and situation as well as differences in *acquired* advantages such as education and skills (Myint, 1977, p. 232). It should be noted here that Porter's differentiation between *Basic-factors,* including natural resources, climate, location as well as labour and *Advanced-factors* such as communications infrastructure, highly educated personnel and university research institutes (Porter, 1998, p. 77), concurs with Adam Smith's distinction between *natural advantages* and *acquired advantages.*

The second example gave critics evidence to show that an explanation of Korea's *comparative advantage* in car exports was to be found in David Ricardo's (1816) *law of comparative advantage* This explained how countries with higher absolute production costs can nevertheless export, as shown in the following quote:

> *Two men can both make shoes and hats, and one is superior to the other in both employments; but in making hats he can only exceed his competitor by one-fifth or 20 per cent; and in making shoes he can excel him by one-third or 33 per cent: will it not be in the interest of both that the superior man should employ himself exclusively in making shoes, and the inferior man in making hats?*

Ricardo, cited in Ruffin, 2002, p.740.

It should be noted here that Porter's *competitive advantage* paradigm – which prescribes that firms in developed countries where wages are high should upgrade and innovate if they wish to export - is simply what *comparative advantage* suggests they should and will do (Davies and Ellis, 2000,1199). Here, critics have concluded that most of the supposedly new elements presented in the *Competitive advantage of nations* have already been taken into account in more recent trade theory.

For example *economies of scale* - resulting from learning curves where costs decline and cost advantages are created so allowing firms to export successfully – are dating back to Adam Smith and the idea of obtaining larger production returns through the use of division of labour (O'Sullivan and Sheffrin, 2003, p. 157). A second example are *technology gap theorie*s - explaining the advantages of countries that introduce new goods drawing on a monopoly that exist until other countries learn to produce these goods – were presented by Posner in 1961. *Technology gap theories* explain that "… in a two-country model, one is much more dynamic than the other, the less dynamic country will have to pay for its imports of new goods by export of traditional goods at less and less favourable prices, and thus will not be able to carry out the massive investment required to increase its own dynamism" (Gandolfo, 1998, pp. 234-235). A third example is Raymond Vernon's *product cycle theory* maintaining that early home demand for advanced goods drives the nation's firms into innovating. Vernon's explanation draws on the notion that firms in the United States spend more on new product development than other countries, not because of a sociological drive for innovation but because more effective communication between the potential market and the potential supplier allows United States suppliers to be the first to recognise opportunities for high-income new products (Vernon, 2001, pp. 193-194). A fourth example is the emergence of multinational corporations - competing through foreign investments. Vogel (1968, p. 57) acknowledged that their superior knowledge of marketing techniques, lower manufacturing costs resulting from mass production on the home market and greater financial resources allowing more aggressive investments, made multinational corporations "the most important and powerful weapons of international businesses that emerged since the end of the second world war".

In sum, the review of the main criticisms of Porter's thesis in this sub-section of the literature review provides evidence that Porter's *competitive advantage* paradigm is essentially "… an informal integration of the comparative advantage theorem with elementary production theory" (Davies and Ellis, 2000, p. 1201) and Porter's claim to have invented a new paradigm is not supported. Furthermore, Porter's elision of *comparative advantage* and *competitive advantage* and the resulting emphasis on innovation and the upgrading of high technology production as sources of *competitive advantage* as well as the devaluation of *comparative (cost) advantages* in the *Competitive advantage of nations* is potentially dangerous as it appears to promote the premature development of high technology industries and to lure industries away from their *comparative advantage* (Davies and Ellis, 2000, p. 1200).

2.3.5 The Four Stages Model

Porter claims that his four stages model sets out and explains "… how economies develop, the characteristic problems [they] faced … and the forces that propel the economy to advance or cause it to falter" (Porter, 1998, p. 546). His model comprises three stages of the successive upgrading of *competitive advantage* associated with rising prosperity followed by one stage of drift and ultimate decline. According to the model, a country drawing all its advantages from basic factors such as natural resources or an abundant and inexpensive labour pool should compete solely on price.

Critics of Porter's thesis highlight that this is exactly what the *comparative advantage* theorem prescribes: a country "… well-endowed with cheap labour will and should produce and export labour-intensive goods" (Davies and Ellis, 2000, p. 1201). Also further stages in the model let itself to be explained by the *comparative advantage* theorem. Cheap labour countries exporting labour-intensive goods increase their national income and when a substantial proportion of that income is saved, the nation's capital stock will increase. The increased resource endowment allows a country to shift its *comparative advantage* towards exporting more capital intensive products. Such a country enters what Porter calls the *investment driven stage*. Also Porter's emphasis on improvement and innovation in methods and technology allows itself to be explained by the emergence of diminishing returns, these setting in when the capital per worker increases and extra investments yield increasingly small increments in output. At this point, a further increase in income is only possible via technological progress.

A more detailed examination of the four stages model learns that on the level of nations various examples demonstrate that the notion that true prosperity is only found in the *innovation- driven stage* is incorrect. Prosperity is also found by nations in the *factor-driven stage* and by those in the *investment-driven stage*. Countries such as Dubai, Kuwait and Saudi Arabia demonstrate that prosperity can be *factor-driven*. These countries are rich in natural resources and show very high productivity and high prosperity per capita. Other countries such as the 'Asian tigers' - Hong Kong, Singapore, South Korea, and Taiwan - who are entering the *investment-driven stage,* invest heavily in technology developed abroad to improve their productivity without bearing the costs and risks of technology development. This allows them to compete on price and to export in abundance, demonstrating that "nations in the investment-driven stage may also be prosperous" (Davies and Ellis, 2000, p. 1201).

To summarise, the main critique for Porter's four stages model provides evidence that the model constitutes a merger of the *comparative advantage* theorem and simple production theory. Furthermore, evidence is provided that Porter's thesis where prosperity is only found with countries in the *innovation driven stage* is not supported by empirical evidence. However, despite its caveats including the apparent lack of novelty and uniqueness, Porter's four stages model is useful in that it captures the elementary production theory for the non-specialist in an attractive way.

2.3.6 Porter’s Clustering Theorem and Urbanisation Economies

Porter acknowledges clustering among the key foundations of his thesis. Clustering according to Porter is based on:

> *… the exchange and flow of information about needs, techniques and technology among buyers, suppliers, and related industries. When such interchange occurs at the same time that active rivalry is maintained in each separate industry, the conditions for competitive advantage are the most fertile.*

Porter, 1998, p. 152.

Porter further maintains that “Geographic concentration of firms in internationally successful industries often occurs because the influence of the individual determinants in the “diamond” and their mutual reinforcement are heightened by close geographical proximity within a nation” (Porter, 1998, pp. 156-157).

Bibliographic evidence of the degree of collaboration with other universities of a number of German universities as presented in Table 2, shows that, with the exception of the Medical university of Hannover - whose major collaborating partner is another German medical university - all the leading universities in a city collaborate most with a university / research institute in the same city.

Table 2: Leading German universities and their major collaborators.

Leading university	Major collaborating partner
Freie Universitaet Berlin	Charite (Berlin)
Universitaet Hamburg	Deutsches Elektronen Synchrotron (Hamburg)
Medizinische Universitaet Hannover	Charite (Berlin)
Ludwig-Maximilians-Universiteat Munchen	Technische Universitaet Munchen
Universitaet Stuttgart	Max Planck Institut for Solid State Physics (Stuttgart)

Scopus, no date.

Porter’s notion of linkages contributes to the discourse on *agglomeration economies* arising from the co-location of related industries building on Alfred Marshall’s (1920) theory that increasing returns to spatial concentration in “… industrial districts arise because of knowledge spillovers … , the advantages of thick markets for specialised skills, and the backward and forward linkages associated with large local markets (Fujita, Krugman and Venables, 1999, pp. 4-5).

Hoover (1937) further developed the concept of *agglomeration economies* by introducing the notion of *urbanisation economies* - economies external to the industry and internal to the city – these emerging from the more general characteristics of the city and relevant to any firm in that city.

More recent, Arthur (1994, p. 87) explained the genesis of industry clusters through the following theory: “If some location by good fortune attracts more firms than the others in the early stages of this evolution, the probability that it will attract more firms increases. Industrial concentration becomes self-reinforcing”.

It emerges from the literature investigating the advantages of clustering that national and international linkages are equally relevant for innovation as are more localised concentrations of firms (Simmie, 2004, p. 1103). Moreover, the results of a survey among over 8,000 firms in the UK show that the main markets for innovative firms are likely to be (inter)national - a finding suggesting that local clustering does not help much in more rapidly understanding new buyer needs. The same survey also reveals that leading innovators value their own organisation as a more important source of information and knowledge than any external source associated with clustering and institutionalised concentrations of information and knowledge such as universities and research organisations which are valued as relatively unimportant. About two-third of the leading innovators included in this survey were not involved in an on-going relationship with an external research institute, including universities. For the UK leading innovators, national collaborations and international linkages, especially in Europe, are considered to be more important than local ones (Simmie, 2004, pp. 1105-1107).

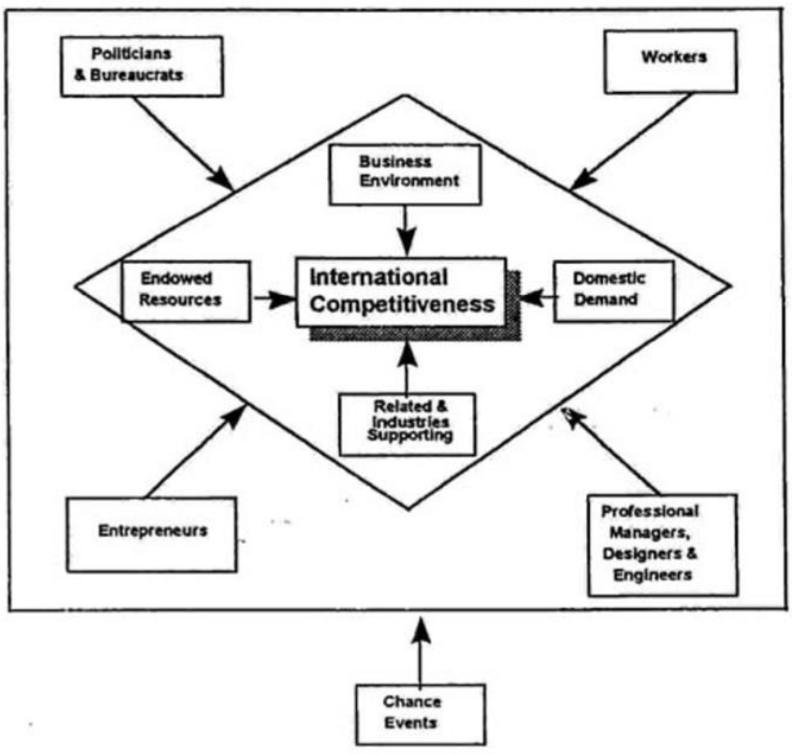
The empirical evidence presented here does not support Porter’s claim that the advantages of clustering are based on “*… the exchange and flow of information about needs, techniques and technology among … related industries*” (Porter, 1998, p. 152) but rather suggests that explanations of collaborations draw on *urbanisation economies* rather than Porter’s cluster theorem.

2.3.7 Extensions of Porter's Diamond Model

Despite the qualities of the diamond model, this paradigm is criticised because of its (limited) scope on national competitiveness (Kim, 2006, p. 124) and a number of extensions have been proposed, the three most prominent examples being: (1) the Nine Factor model (NF); (2) the (Generalised) Double Diamond model (GDD); (3) the Dual Double Diamond model (DDD), all of which are discussed in this sub-section of the chapter.

The Nine Factor model aims to explain more clearly the role of human factors in the national competitiveness of countries whose major sources of competitiveness are human, as in less developed or developing countries. Here, the Nine Factor model expands the four *physical* factors included in Porter's diamond: *Factor conditions, Demand conditions, Related and supporting industries and Firm strategy, structure and rivalry,* with four human factors: *Workers*, *Politicians & Bureaucrats*, *Entrepreneurs,* and *Professionals*; and one exogenous variable *Chance Events* (Cho, Moon and Kim, 2009, p. 86).

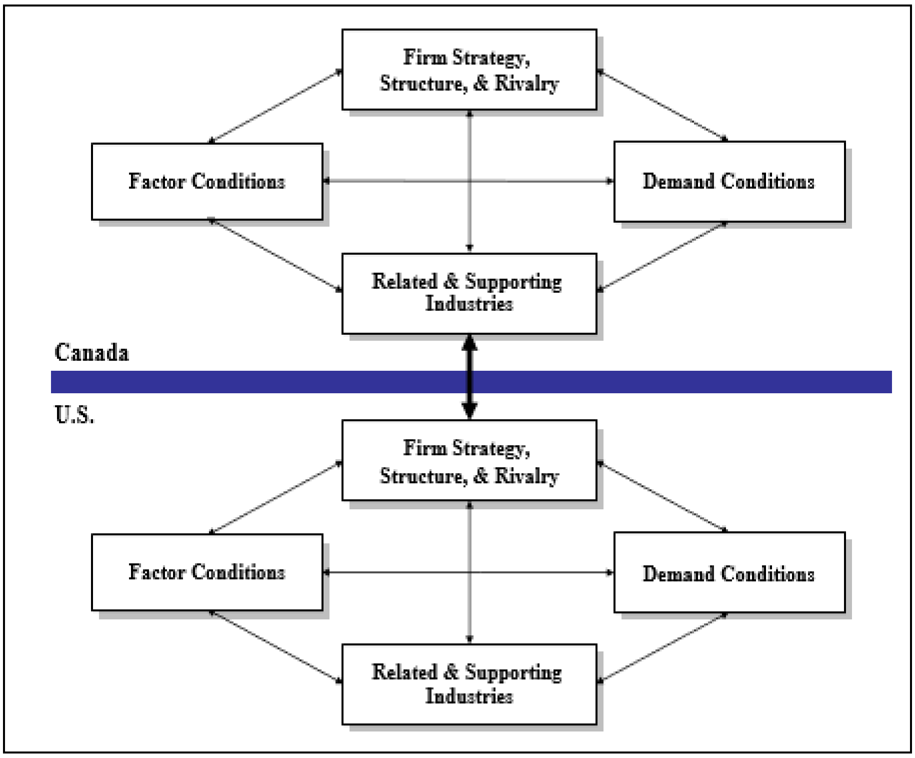
Figure 7: The Nine Factor Model



Cho, 1994, p. 21.

Rugman (1991 and 1992) highlights that the national scope of the variables in Porter's diamond makes it difficult to explain the competitiveness of small economies, for example Canada, which rely heavily on large foreign markets or *triads*[9], for example the US, and suggests incorporating the international context of national competitiveness in an extension of the diamond mode which he named the Double Diamond model, as depicted in Figure 8.

Figure 8: The Double diamond model



Kim, 2006, p. 125.

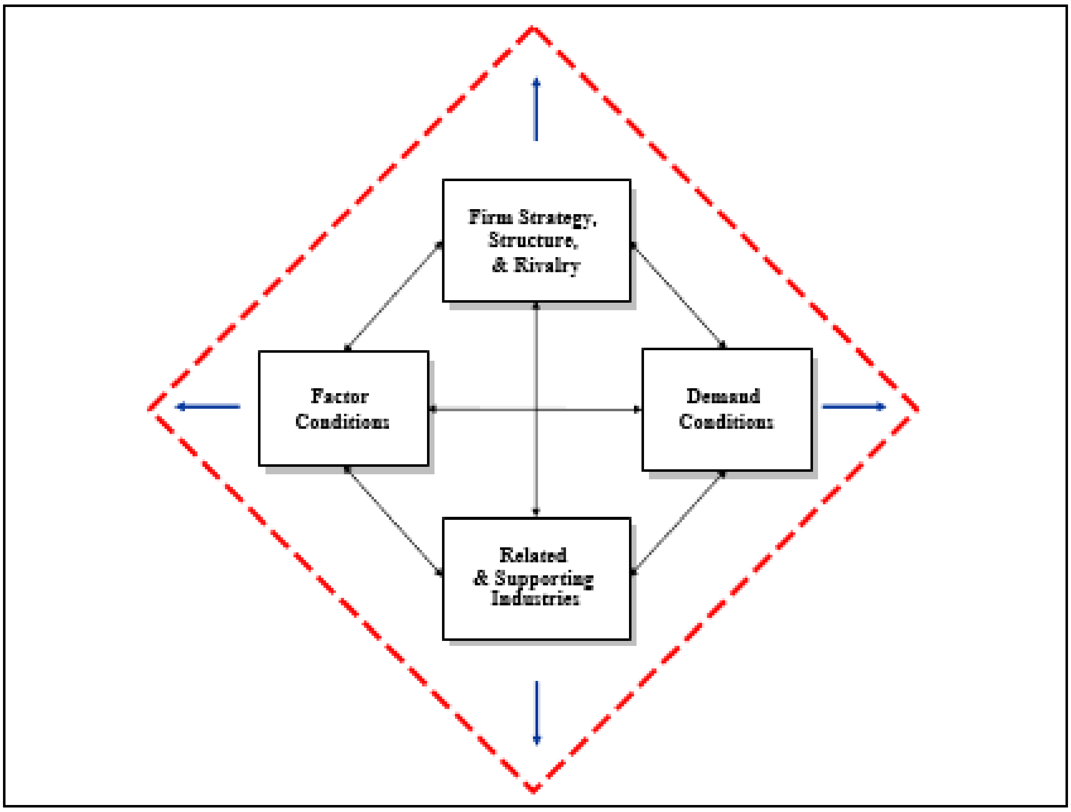
The Double Diamond model incorporates multinational activities by "… linking the domestic diamond of each country to that of a relevant *triad*, thus incorporating the international context of national competitiveness" (Cho, Moon and Kim, 2009, p. 85).

To accommodate nations trading with both *triad* and *non-triad* countries, the original Double Diamond model is further extended into the Generalised Double Diamond model comprising a national and an international diamond, the former

[9] In the relationship of for example of Canada and the US the US is referred to as a 'triad' country whereas the term 'non-triad' countries refers to economies other than the 'triad' with whom Canada maintains business relationships.

assessing the utilisation of its national resources and the latter aggregating the assessment of all of the non-domestic diamonds, as depicted in Figure 9.

Figure 9: The Generalised Double Diamond

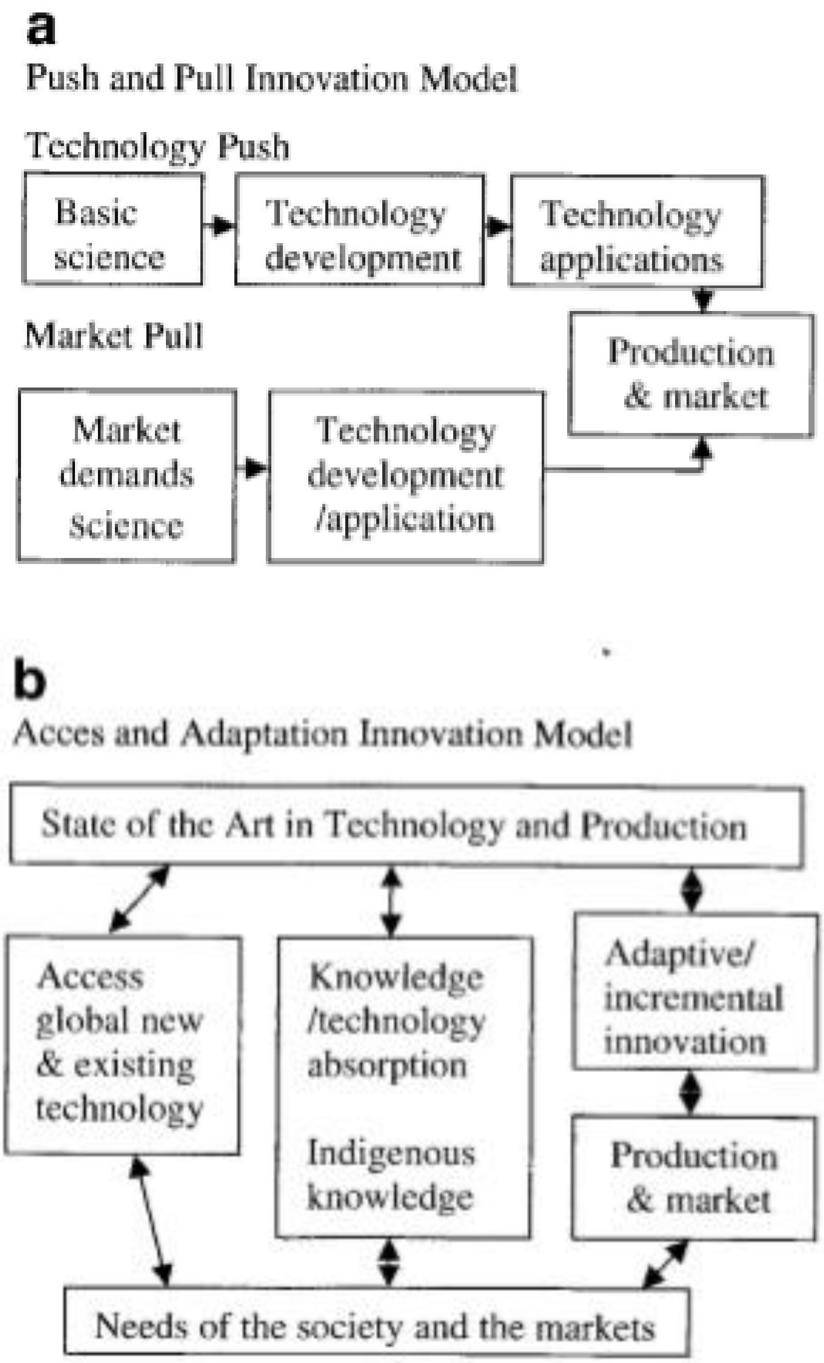


Kim, 2006, p. 127.

Another new feature of the Generalised Double Diamond model is that it acknowledges the differences in innovation in developed countries, as explained by the *Push and Pull Innovation Model* and innovation in developing countries, as explained by the *Access and Adaptation Model*.

The *Push and Pull Innovation Model* comprises the two leading forces in developed countries to upgrade competitiveness via the commercialisation of new technology. Here: (1) basic research leads to new inventions; or (2) market demands drive the development of new technology, both depicted in Figure 10 whereas the *Access and Adaptation Innovation Model* encompasses: (1) the awareness of existing knowledge; (2) the availability of complementary assets; (3) the accessibility to advanced technology and markets; (4) the affordability of conducting innovation as essential ingredients of incremental and adaptive innovation (Carayannis and Wang, 2012, p. 282) as depicted in Figure 10.

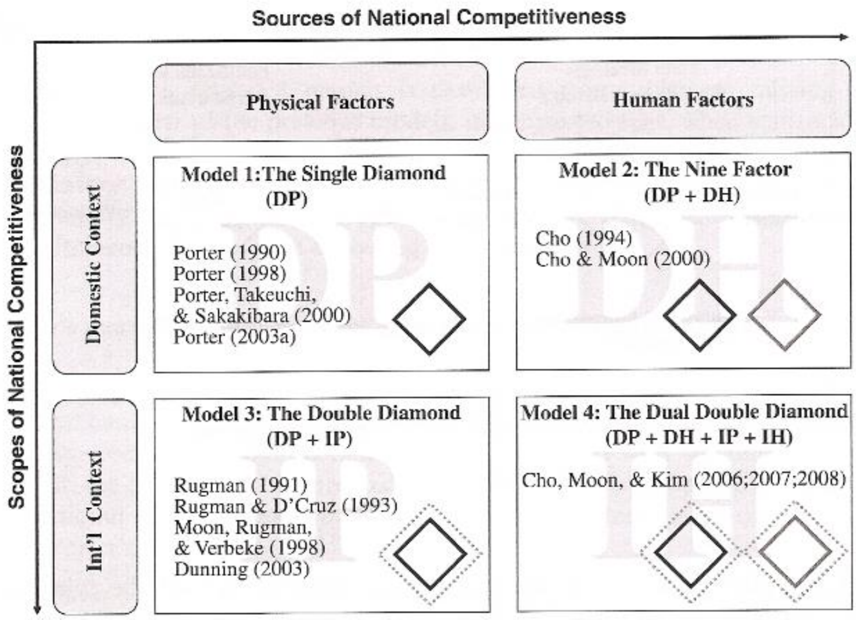
Figure 10: The *Push and Pull Innovation Model* and the *Access and Adaptation Innovation Model*



Carayannis and Wang, 2012, p. 281.

Critics maintain that Porter's single diamond and its extensions - the Nine Factor model and the Generalised Double Diamond ignore the role of international human factors in enhancing national competitiveness such as, the *brain drain*. The integration of Porter's single diamond, encompassing *domestic physical* factors, with the Nine Factor model, expanding *physical* factors with *human and exogenous factors* and the Generalised Double Diamond, including the international diamond, have led to the Dual Double Diamond model which measures the physical factors and the human factors of national competitiveness in domestic and international contexts (Cho, Moon and Kim, 2009, p. 88), as depicted in Figure 11.

Figure 11: Porter's diamond model and its extensions.



Cho, Moon and Kim, 2009, p. 88.

A limitation of the extensions of Porter's diamond model is that each model may yield different assessments for the same countries. It is therefore critical for a valid analysis that the correct model is chosen. Table 3 presents the empirical data for testing the four models in assessing the national competitiveness of a number of countries. As shown in the table, for Germany the assessment with Porter's single diamond is closest to the median (15) of all four models and will therefore be further used in this study.

Table 3: Changing rankings of national competitiveness using different models.

Country	*SD*	*NF*	*GDD*	*DDD*
United States	1	1	1	1
Netherlands	2	2	2	2
Canada	3	3	4	4
Denmark	4	4	3	3
Sweden	5	5	5	7
Finland	6	6	12	16
Norway	7	7	10	10
Australia	8	8	17	11
Japan	9	14	13	18
Israel	10	9	14	12
Switzerland	11	10	9	9
Austria	12	16	16	17
New Zealand	13	17	19	21
Singapore	14	11	7	6
Belgium	15	12	11	8
Germany	16	19	8	13
Hong Kong	17	13	6	5
France	18	15	15	15
Kuwait	19	26	21	23
Chile	20	21	20	20
United Kingdom	21	18	18	14

Extract from: Cho, Moon and Kim, 2009, p. 94.

Put succinctly, what has emerged from this sub-section of the chapter are a number of limitations of Porter's diamond model and that these have initiated the development of particular extensions of the model to remedy the shortcomings. However, the emergence of such extended models has had two side effects: (1) the extended versions of the diamond have (in part) lost the compelling simplicity of the original diamond model, and (2) the use of different models is likely to yield different assessments for the same countries.

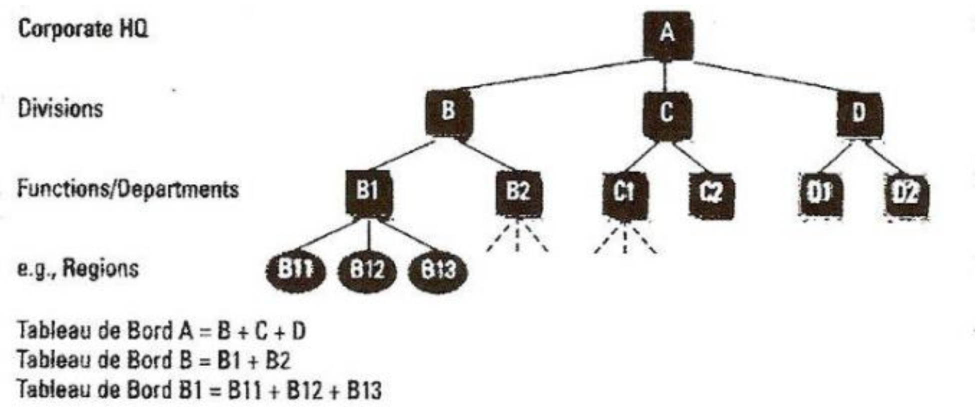
2.3.8 Articulation of Alternative Performance Measurement Models

Neely (2007, p. 144) maintains in his seminal review of developments in the theory and practice of performance measurement systems that a*ccounting performance measurement* materialised alongside the development of double-entry bookkeeping in the thirteenth century (Neely, 2007, p. 144). The origins of this statement draw on a Venetian manuscript published before 1494 (Yamey, 1947, p. 272).

Key drivers of the development of *accounting performance measurement* emerge from a review of this topic covering the period from 1850 through 1915 by Robert Kaplan, one of world's best known business scientists. His review discloses that in the first half of the 19th century, when industries such as textile mills and railroads became more complex, cost accounting systems based on a firm's double-entry bookkeeping informed system managers about costs, productivity and the use of raw materials so that they were able to monitor the efficiency of their firms (Kaplan, 1984, p. 391). This review further reveals that in the late 19th century, emerging mass distribution and mass production enterprises adapted the accounting systems of the textile mills and railroads to generate performance reports very similar to those that would be used in the following 100 years to monitor a firm's performance (Kaplan, 1984, p. 392). Among the key contributions to knowledge of this review relevant to the present study is further that it calls for new research by academic researchers who "… leave their offices and study the practice of innovating organisations … to describe and document innovative practices that seem to work for successful companies" (Kaplan, 1984, p. 415). Such research should be "more inductive than deductive" (Kaplan, 1984, p. 415). Kaplan supports his call for new research with reference to Henry Mintzberg's description of the philosophy and strategy of small-sample field-based research (Kaplan, 1984, p. 415).

One of the earliest performance measurement frameworks emerged in France at the turn of the twentieth century: the 'Tableau de Bord' (=dashboard). This framework was developed by French process engineers who wanted to improve their production processes by gaining a better understanding of the cause-and-effect relationships between their actions and process performance (Epstein and Manzoni, 1997, p. 29).

Figure 12: Tableau de Bord



Epstein and Manzoni, 1997, p. 30.

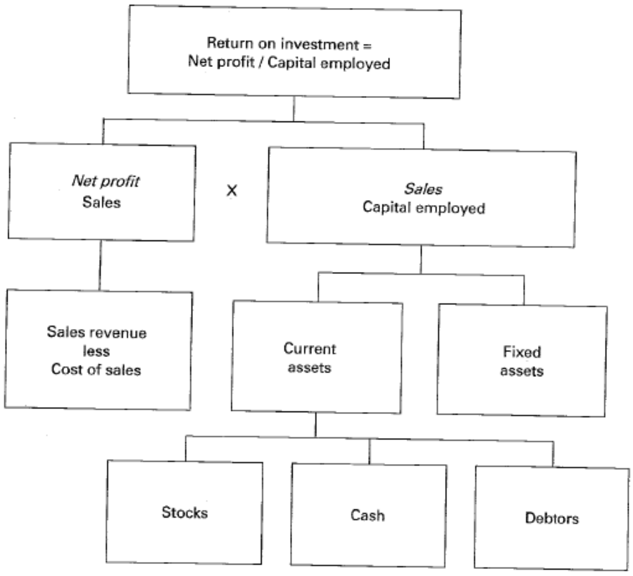
The Tableau de Bord provides top management with a succinct overview by means of a few key parameters to support decision making and to avoid information overload. Here, the indicators used in the Tableau de Bord are not limited to financial indicators but are developed in the context of the company's or unit's mission and objectives (Epstein and Manzoni, 1997, p. 29).

The relevance of reference to the Tableau de Bord in this literature review is that the Tableau de Bord "From a conceptual point of view … is quite close to Kaplan and Norton's Balanced Scorecard" (Epstein and Manzoni, 1997, p. 34) which was developed almost 100 years later. Hereby must be acknowledged that publications assessing the Tableau de Bord highlight the need to tailor the Tableau de Bord to each company and to each manager within the company (Epstein and Manzoni, 1997, p. 34), thus portraying the Balanced Scorecard as "a special case" of the Tableau de Bord, the former being more rigid and disregarding potentially important dimensions of company performance. The advantages of both frameworks are that they protect against two dangers: the danger of the domination of one perspective – for example financial measures - and the danger of missing one of the four dimensions as proposed in the Balanced Scorecard (Epstein and Manzoni, 1997, p. 34).

Between 1880 and 1925, numerous innovations in accounting performance measurement were developed. Here, the aim of *improvement* of performance was the driving force behind developments in *measuring* performance. The emergence of vertically integrated multi-activity enterprises in the early 1900s can be recognised as the impetus for modern managerial control systems.

The Du Pont pyramid of financial ratios, developed in the 1910s is the archetype from which the reporting and evaluation systems for virtually all modern companies have evolved (Kaplan, 1984, pp. 396 and 399). Within this framework, the Return on investment (ROI) ratio serves as an indicator of the efficiency of the various operating departments and as a measure of the financial performance of the whole company. (Kaplan, 1984, p. 398).

Figure 13: The Du Pont Company formula for Return on investment



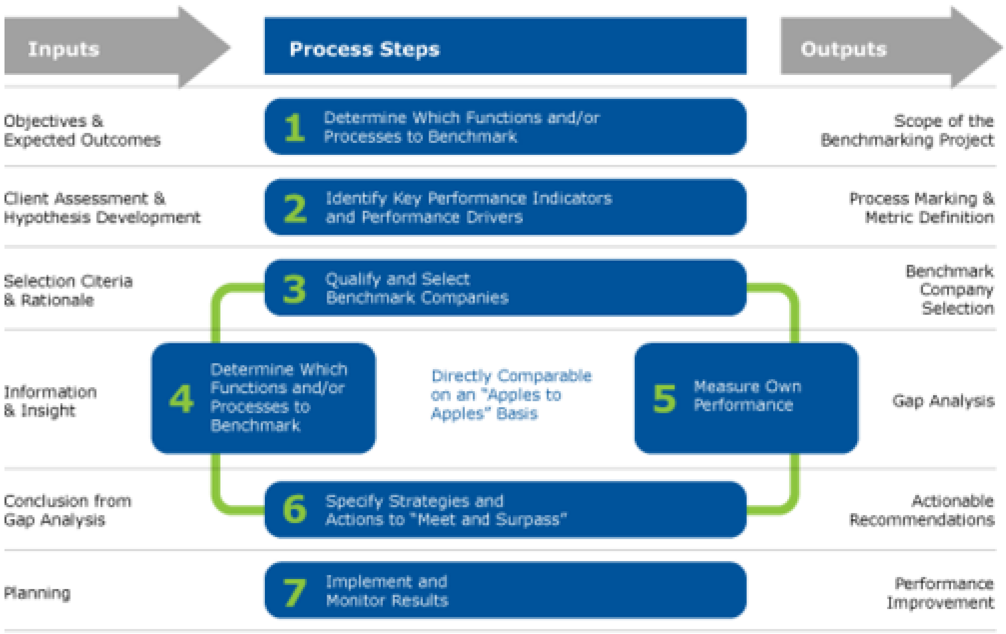
Neely, 2007, p. 14.

It should be noted here that these performance measurement practices were developed by managers and process engineers rather than by academics and their success in corporations such as Du Pont or General Electric provided a credible basis for their rapid diffusion into other organisations (Kaplan, 1984, p. 401).

The contribution to knowledge by the review of the development of performance measurement frameworks in this chapter, is the acknowledgement that following the developments into the mid-1920s "… there ..[were].. virtually no major innovations by practicing managers or management accountants during the .. [next]… 60 years to affect contemporary management accounting thought' (Kaplan, 1984, p. 401). Also other authors confirm that "… [the] management accounting systems used today are based on assumptions that were made 60 years ago" (Neely et al., 1995, p. 89). Drawing on this assumption Neely argued in 2005 "… that the field of performance measurement … is less than 15 years old” (Neely, 2005, p. 1270). He highlighted that the period before 1990 “… involved a process of “problem identification” – recognising and discussing the weakness of measurement systems and their organisational impact” (Neely, 2005, p. 1271). Neely - in an attempt to classify the phases of development of performance measurement research - characterises the following period of the early 1990’s as “the search for frameworks” (Neely, 2005, p. 1271).

The first book concerning benchmarking was written by Filer et al. (1988) and published by Kaiser Associates, a US consulting firm. Its methods have been adopted by industries and public sector organisations worldwide as a new governing technique which seeks to improve efficiency and quality. By 2000, around two-thirds of UK public sector organisations were using benchmarking (Triantafillou, 2007, p. 829).

Figure 14: The benchmarking process



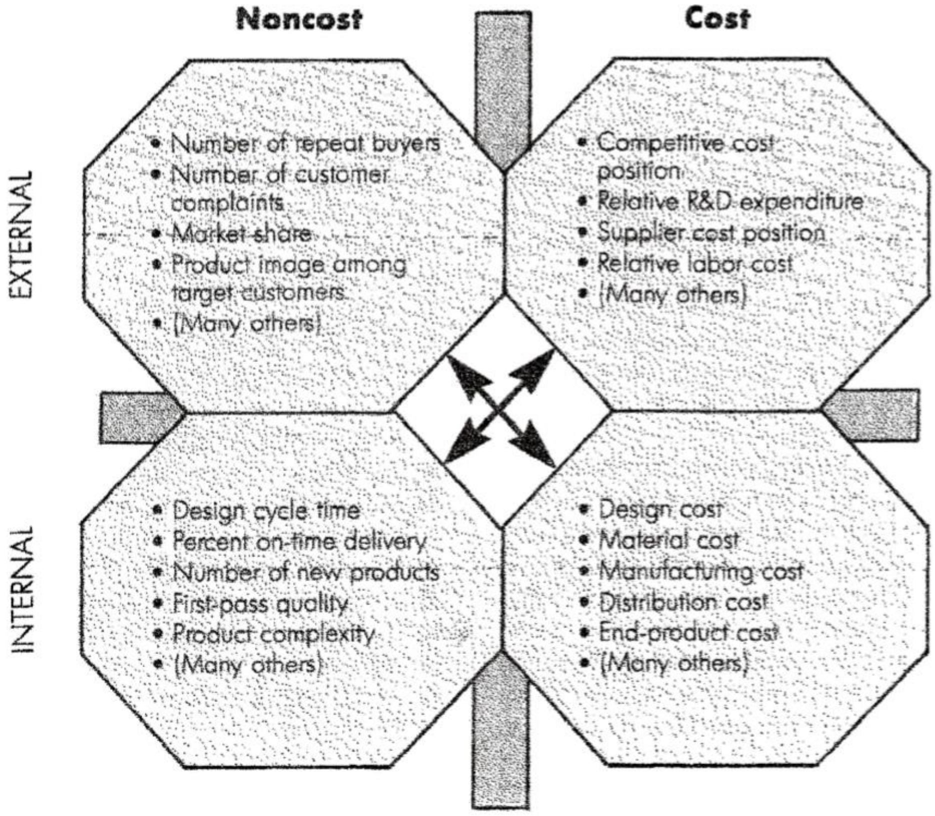
Kaiser Associates, no date.

Benchmarking differs from other evaluation techniques in that it attempts to visualise ‘best practice’ through *normalizing* comparison. *Normalising* here refers to “.. the process by which a group produces and updates the *normal* as the point of departure for the structuring of their reflections and negotiations over how to act and decide on a certain issue” (Triantafillou, 2007, p. 834).

Few substantial objections to benchmarking are to be found in the literature - most of these concern the accuracy of benchmarking and the way it is imposed on organisations. The real danger of benchmarking is that it produces "… knowledge that strongly urges if not forces those organizations that fall below the normal to launch procedural or organizational changes [even if those organizations and their users are happy about their services] … the organization is compelled to either change its services in a direction that will make it far better in the (next) benchmarking or, at the very least, to come up with some extremely convincing arguments for not doing so" (Triantafillou, 2007, pp.844-845).

One of the frameworks that emerged from "the search for frameworks" seeking to overcome the weakness of earlier measurement systems - drawing exclusively on financial measures - by the inclusion of additional non-cost criteria such as customers, market share, operations and new product development, is the Performance Measurement Matrix (PMM) developed by Keegan, Eiler and Jones in the late 1980s. The development of the PMM was not drawing on a comprehensive theoretical framework but on field-based evidence collected over 15 years by Keegan et al. from working with companies "whose aggregated revenues amount to more than $500 billion" (Keegan, Eiler and Jones, 1989, p. 50).

Figure 15: The Performance Measurement Matrix (PMM) by Keegan, Eiler and Jones



Keegan, Eiler and Jones, 1989, p. 48.

With their work, the developers of the *Performance Measurement Matrix* contribute to knowledge by the disclosure of guiding principles on which frameworks should draw: “performance measures … should derive from strategy … are hierarchical as well as integrated across business functions …must support a company’s multidimensional environment … [and] based on a thorough understanding of costs” (Keegan, Eiler and Jones, 1989, p. 50). Thus, these principles “… reflect the need for more balanced measurement systems (Neely, 2007, p. 145). A further contribution to knowledge by Keegan et al. is their reference to the Key Metric Approach (KMA) - a technique including the use of data collection forms and summary computer models - to address cost drivers and performance measures in large companies (Keegan, Eiler and Jones, 1989, p. 50).

The need to identify the right drivers of performance to achieve the desired strategic objective is reflected in the ‘Results-determinants framework’ as developed by Fitzgerald et al. in 1991.

Figure 16: The results-determinants framework by Fitzgerald et al.

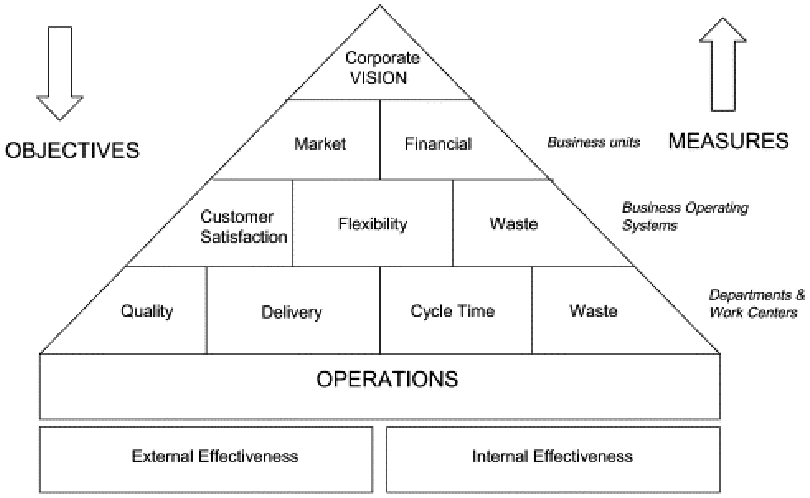
Results	Competitiveness
	Financial performance
Determinants	Quality
	Flexibility
	Resource utilization
	Innovation

Neely, 2007, p. 147.

The development of this framework is contributing to the discourse about the concept of causality by which the authors emphasise "… that the results obtained today are a function of past business performance in relation to specific determinants" (Neely, 2007, p. 146).

The Performance Pyramid developed for the Wang Laboratories in the early 1990s by Cross and Lynch "… contains the objectives and measures that link a company's day-to-day operations to its vision" (1992, p.21). The top of the pyramid refers to the vision of the company and includes its market definitions and competitive approach. The second level is the level of the business units, including the firm's key results, objectives and measures with short-term targets and long-term goals. The right-hand side includes financial measures, while the centre of the pyramid includes the operating system connecting the top-level with day-to-day operations. The bottom of the pyramid links the departmental performance with company strategy (Cross and Lynch, 1992, pp. 21-22).

Figure 17: The Performance Pyramid by Cross and Lynch



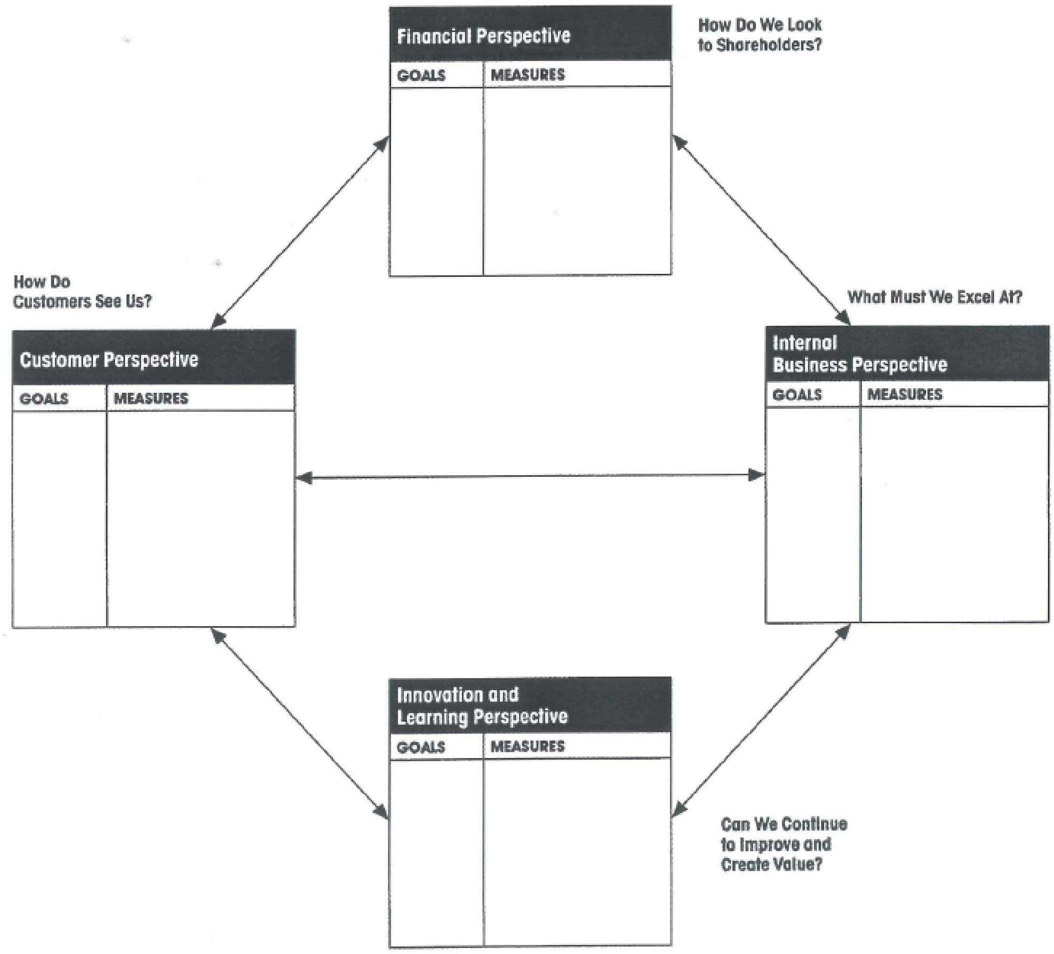
Nilson and Olve, 2001, p.350.

The gaps in knowledge which are addressed by the development of the Performance Pyramid are the shortcomings of continuous improvement programs such as Total Quality Management (TQM) and Just-in-Time (JIT) that emerged in the 1980s comprising *non-essentials* becoming subject to interpretation, and loss of focus and painful slow progress because of the lack of a clear link between strategic priorities and the improvement programs. Therefore, aim of the Performance Pyramid is "… putting the organisation on track [by] defining and managing a few critical performance indicators … that link a company's day-to-day operations to its vision" (Cross and Lynch, 1992, p.21).

It should be noted here that conceptual there is much congruence between the Tableau de Bord and the Performance Pyramid: offering the company's management to stay on track via a few critical performance indicators and linking (departmental) performance with company strategy. The evidence of the value of the Performance Pyramid for professional practice is presented by Cross and Lynch by reference to a few cases: Federal Express, General Electric and a circuit board assembly plant (Cross and Lynch, 1992, pp. 24-25).

By incorporating many of the attributes of earlier performance measurement systems and linking measurements more explicitly to organisational strategy, Kaplan and Norton (1992) devised their seminal *Balanced scorecard* - a performance measurement framework where financial measures are supplemented with operational measures, these being regarded as the drivers of future financial performance. The Balanced Scorecard's development is informed by empirical evidence emerging "During a year-long research project with 12 companies at the leading edge of performance measurement …" (Kaplan and Norton 1992, p. 71).

Figure 18: The balanced scorecard



Kaplan and Norton, 1992, p. 72.

Kaplan and Norton (1992, p. 72) provide managers with a view on performance simultaneously from four perspectives, to do with: (1) finance; (2) customers; (3) internal business; (4) innovation and learning. Thus, they avoid information overload by limiting the number of measures used. Here, the scorecard *balances* the emphasis on contradictory objectives or measures and links performance drivers with outcome measures in a *cause-and-effect* relationship.

The gap in knowledge which is addressed by the development of the Balanced Scorecard is of a conceptual nature and involves the causal relationships between the *attributes* of the *object* to be measured and the *measurements* or *indicators* used to capture the attributes in numerical values (as explained in section 2.3.1). The relationships between the financial perspective and the three other perspectives are explained through synthesising creating value for customers and creating shareholder value as conceptualised in the following *cause-and-effect* chain:

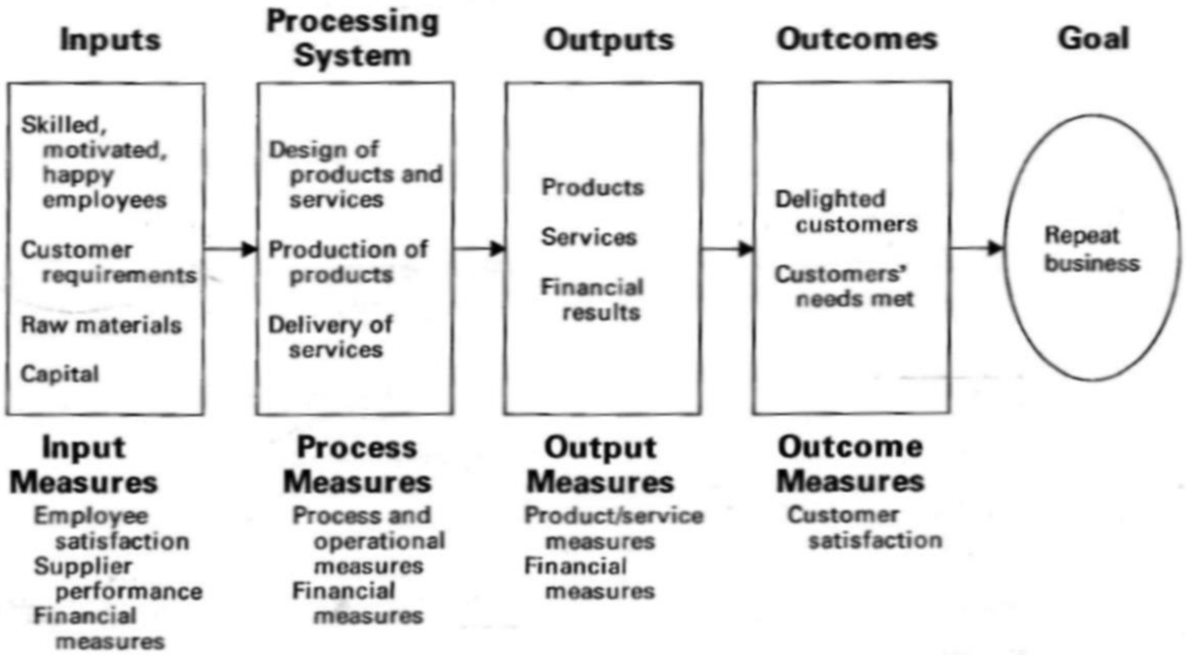
measures of organizational learning and growth -> *drivers* of -> *measures* of the internal business processes -> *drivers* of -> *measures* of the customer perspective -> *drivers* of -> financial *measures*

Critique emerging from the literature on this train of thought relates to clarifying the set of causal factors of a company's financial performance and the translation into key performance indicators. The importance of choosing the right indicator emerges from the following quote: "...performance indicators which are faulty … [result] … in dysfunctional organizational behaviour and sub-optimal performance" (Nørreklit, 2000, p. 67).

The Balanced Scorecard is employed by several UK public sector organisations because this tool makes it possible to ".. combine accountancy measures with three other 'soft' metrics" (McAdam and Walker, 2003, p. 876). However, it was found that the Balanced Scorecard could not simply be applied in the public sector without considerable adaptation. For example, the private sector nomenclature of the Balanced Scorecard needs to be adapted to fit within the cultural, structural and strategic context of the public sector. Despite the paucity of research concerning the use of the Balanced Scorecard as regards improving quality in the public sector, it was found that the key strength of the *Balanced Scorecard* is its ability to help "… translating strategic objectives into a tangible improvement in operations at service level" (McAdam and Walker, 2003, p. 876). However, the greatest potential weakness in misapplication occurred "… where management focussed upon command and control measures to install appraisals systems, and did not set these targets collaboratively" (McAdam and Walker, 2003, p. 890).

A more simplified view on the relationship between *attributes* of the *object* and *measurements* or indicators is presented in the 'Inputs-processing system-outputs-outcomes framework' by Brown (1996, as cited in Neely, 2007, pp. 146-147) drawing on the assumption of a linear relationship between inputs, process, outputs, outcomes and goals.

Figure 19: The inputs-processing system-outputs-outcomes framework by Brown

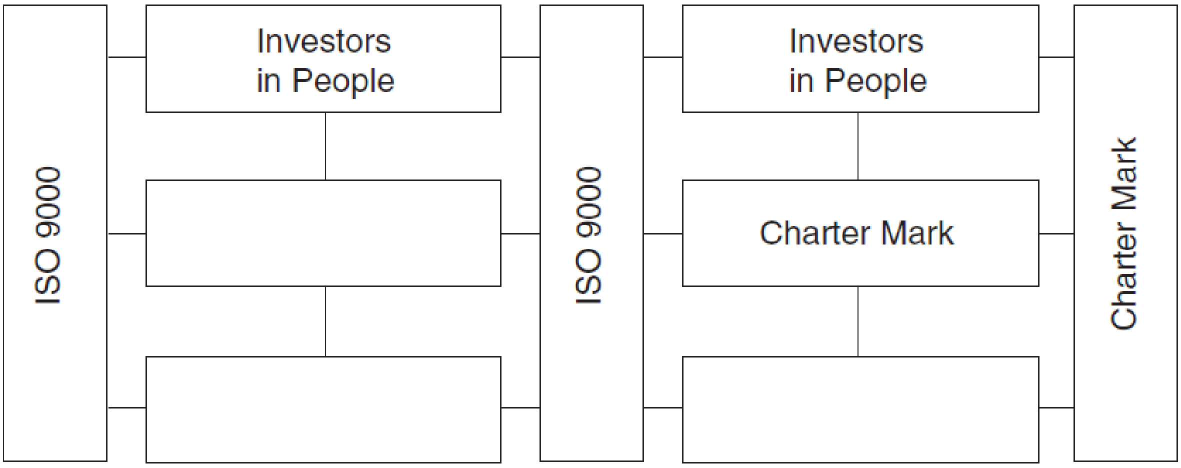


Neely, 2007, p. 147.

It is however recognised in the literature that this assumption is an oversimplification of reality (Neely, 2007, p. 147). Nevertheless, this framework "… has proved particularly popular in the public sector" (Neely, 2007, p. 147) because of its distinction between *outputs*, defined as products, services and financial results, and *outcomes*, defined as delighted customers and the meeting of customers' needs.

The *Business Excellence Model*, developed in the private sector by the European Foundation for Quality Management "… explicitly highlights the enablers of performance improvement and identifies result areas that should be measured" (Neely, 2007, p. 149). This model has been recognised by the Cabinet Office (UK) as the key approach in improving public sector quality. It also provides a framework within which continuous improvement can be measured.

Figure 20: Business Excellence Model

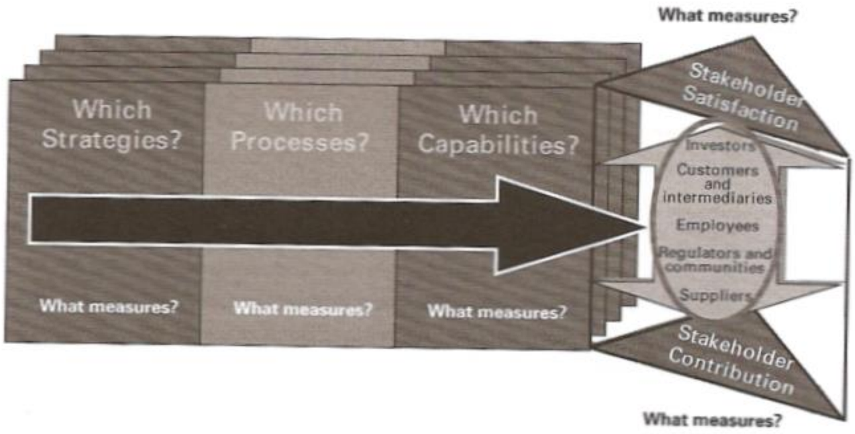


McAdam and Walker, 2003, p. 877.

Figure 20 highlights where different quality models fit within organisational performance. Compared with the Balanced Scorecard, this model addresses different areas of performance, thereby highlighting the complexity of the causal relationship between the enablers of performance and performance itself. It should further be noted that some of the enablers in this model are not readily measurable (Neely, 2007, p. 149).

The *Performance prism* developed by Neely in 2001 (Neely, 2007, pp. 151-156) features as a novelty the *stakeholder-centric perspective* comprising stakeholder satisfaction and stakeholder contribution. Stakeholders in this model include traditional stakeholders such as customers, employees and suppliers, as well as emerging stakeholders such as regulators, legislators and pressure groups. Additionally, results (stakeholder satisfaction/contribution) in the framework are regarded as a function of the determinants (the other prism facets).

Figure 21: The performance prism



Neely, 2007, p. 155.

An assessment of the status of performance measurement as an area of research has emerged from a review of 76 empirical studies of contemporary performance measurement (CPM) systems. This shows that a lack of consistent evidence remains concerning the impact of performance measurements on a firm's superior performance: a "direct link between contemporary performance measurement systems and organisations' superior performance might be misleading due to the internal and external factors that play a role in economic performance evaluation" (Franco-Santos et al., 2012, p. 100).

What emerges from the review is that this area of research is informed by six well-known theories: (1) agency-theory; (2) contingency theory; (3) goal-setting theory; (4) equity theory; (5) a resource-based view of the firm; (6) cognitive-based psychology research. Additionally, existing economic, psychological and sociological theories are also used to theoretically underpin the explanation of the systems. It further emerged from the review that about a third of the studies included had no explicit theoretical underpinning. These findings suggest that this area of research is still at the modelling stage (Franco-Santos et al., 2012, p. 99).

The aim of the following two sub-sections of the chapter is to provide a clear articulation of the measure(ment)s used in the diamond model as well as a review of the management literature on measurements. Here, the development of performance measures in the context of the emerging imperfections or critiques concerning such measurements will be borne in mind.

2.3.9 Articulation of Measures in the Diamond Model

To identify the fundamental forces of national competitive advantage, Porter, along with a group of over 30 researchers, conducted a four-year study of relatively sophisticated industries and industry segments in ten important trading nations. His study was limited to ten nations owing to time and resource constraints. The data for the study was collected from available statistical data, supplementary published sources and field interviews and encompassed three points in time: 1971, 1978, and 1985. Here, Porter articulated the difficulty he was experiencing finding the right measurements for competitive advantage declaring:

> *… many potential measures of competitive advantage can be misleading. Neither domestic profitability, nor size of the industry or the leading company, nor the existence of some exports is a reliable indicator of competitive advantage. Measuring the presence of true competitive advantage statistically is challenging.*

Porter, 1998, p. 25.

In his work Porter chose: (1) the presence of substantial and sustained exports and/or (2) significant outbound foreign investments (Porter, 1998, p. 25) as indicators of international competitive advantage.

Porter's diamond model of competitive advantage comprises four broad *attributes,* these being referred to as *determinants* which shape the condition of a company's competitive advantage: *Factor conditions; Demand conditions; Related and supporting industries; Firm strategy, structure and rivalry.* These *determinants* establish the company's competitive environment, both individually and as a system.

Factor conditions comprise the *inputs* necessary to compete, and can be grouped into a number of broad categories:

- Human resources including the quantity, skills and cost of the labour force as well as working hours and work ethics.

- Physical resources including the richness, quality, accessibility and cost of land, minerals or timber, hydroelectric power sources and/or fishing grounds, in addition to comprising climatic conditions and geographic location relative to suppliers and markets.
- Knowledge resources, these encompassing the scientific, technical and market knowledge that resides in universities, governmental institutes, private facilities, literature, databases and other sources.
- Capital resources comprising the amount and cost of capital available to finance industry and trade.
- Infrastructural resources, comprising the type, quality and cost of transportation systems, communication systems, mail and parcel delivery systems, payments or funds transfer systems, health care systems as well as the attributes that establish an attractive living and working place, including housing stock and cultural institutions.

Among the *inputs* necessary to compete Porter distinguishes between *Basic factors* - often passively inherited low-cost factors – and the more significant factors for competitive advantage *Advanced factors* which comprise unique high-quality human, knowledge and infrastructure resources which have developed through large and often sustained investments.

Demand conditions shape the rate and character of a firm's improvement and innovation; its attributes can be categorised according to three broad categories: (1) the structure of the segments and demand; (2) the sophistication of the buyers; (3) the level of anticipation of the buyer's needs. Measurements of demand include the size and growth of the segments, the economies of scale and learning, the pressure to meet buyers' standards, the anticipatory value of the buyer's needs - including mechanisms for the transmission of domestic preference to foreign markets, the independence of buyers and proximity and cultural similarity.

Related and supporting industries create advantages via "efficient, early, rapid, and sometimes preferential access to the most cost-effective inputs … [but] … more significant[ly] …via linkages between the value chains of firms and their suppliers". Here, Porter acknowledges that the exchange of R&D and joint problem solving, especially between managerial and technical staff, along with cultural similarity, lead to faster and more efficient solutions (Porter, 1998, pp. 101 and 103). *Related and supporting industries* can be identified on the basis of coordination or sharing activities in addition to the involvement of complementary products in the value chain when competing. Three measures were used by Porter in his *The Competitive Advantage of Nations* to assess a given industry: (1) the *export share* or the nation's share of the world market economy exports in the industry; (2) the *share of the total country exports* - this being the absolute share of a nation's total exports represented by a given industry or industry cluster; (3) the *share of world cluster exports* as represented by the share (percentage) of a given nation of the total world exports of all specialty inputs to a given industry.

Firm strategy, structure and rivalry govern how companies are created, how they are organised and how they are managed as well as the nature of national rivalry. The difficulty in identifying appropriate measurements for this corner of the diamond lies in the plethora of aspects impacting on how firms are managed and organised. Among the most important aspects, Porter acknowledges: (1) attitudes towards authority; (2) the norms of interpersonal interaction; (3) attitudes related to relationships between workers and management; (4) social norms of individualistic or group behaviour; (5) professional standards; (6) attitudes towards competing globally and learning new languages. All of these aspects draw on intangible and/or unique national conditions. National rivalry refers to those domestic competitors that "… not only [fight] for market share but for people, technical breakthroughs, and, more generally, "bragging rights"" (Porter, 1998, p. 119). In his *The Competitive Advantage of Nations*, Porter uses the number of companies in selected industries as a measurement of national rivalry (Porter, 1998, p. 118).

In addition to the use of measurements of the four broad *attributes* or *determinants* which shape the condition of a company's competitive advantage, the following measurements were used by Porter to analyse national trade patterns: (1) the *Share of total world exports*; (2) Export value; (3) Import value; (4) the Share of total U.S. Exports (Porter, 1998, pp. 745-772).

While the articulation of measures in this sub-section of the chapter provides a reliable summary of what is written about measures in *The Competitive*

Advantage of Nations "… the reader [is] none the wiser about how competitive advantage is to be defined, let alone measured" (Davies and Ellis, 2000, p. 1194). Among the many factors contributing to this omission is the confusion created by Porter by defining national productivity as "… the only meaningful concept of competitiveness at the national level …" (Porter, 1998, p. 6). It should be noted here that in the management literature, *productivity* is usually interpreted as a "… measure of the efficiency with which resources are used" (Eilon, 1990) and *competitiveness* as "… the ability to secure market share against competition (Scott and Lodge, 1985). When using the market share interpretation of competitiveness, what should be taken into consideration is that export shares are affected by exchange rate changes and labour costs. Porter however contradicts this by asserting that exchange rates and the employment of citizens at low wages "clearly [say] something about a nation's industry, but none relate to national economic prosperity" (Porter, 1998, pp. 5-6). Similar confusion emerges when determining the prosperity of a nation. In *The Competitive Advantage of Nations,* the prosperity of a nation is sometimes determined by the income of that nation's residents and at times by the group of firms for whom the country is the home base. The consequences of this elision are most clear in the case of Singapore, which has the highest national income per capita in the world. However, were it to be measured by the activities of firms for whom Singapore is a home base, its residents would be poor people (Davies and Ellis, 2000, p 1196).

In an attempt to respond to the challenge of measuring the presence of true competitive advantage left open by *The Competitive Advantage of Nations,* the following sub-section of the chapter presents a review of the literature in terms of the most salient measures used in the corporate sector.

2.3.10 Articulation of Alternative Measures

The challenges posed by decisions about what measures to use in performance measurement frameworks are enduring. For example emerges from a review of the literature on this topic from the mid-1950s that already in the 1940s the Soviets had come to the conclusion that no *single measure* was adequate to measure the success of a company (Ridgway, 1956, p. 243). In the review are examples of dysfunctional consequences from the use of inadequate *single measures* highlighted, for example in a narrative about Soviet plant managers who, to establish new monthly production records, neglected repairs and maintenance which led to distinct falls in production in the subsequent months. Problems with *single measures* are also reported from outside the Soviet Union, for example in a study presenting a narrative about a monthly case quota for investigators at a federal law enforcement agency where investigators picked only the easy and fast cases to reach their monthly quota (Ridgeway, 1956, p. 241).

The gap in knowledge which is arising from the review of the literature on performance measures until the mid1950s is the apparent inadequacy of *single measures* and their impact on motivating individuals within a company, by which *wrong* measures may have a detrimental effect on the original aim of introducing performance measurement (Ridgway, 1956, p. 243). This conclusion is drawing on the work of numerous authors including Peter M. Blauw, Chris Argyris, David Granick, Joseph S. Berliner and H. A. Simon et al. (Ridgeway, 1956, pp. 241-242) which makes this conclusion trustworthy and plausible.

The recognition of the shortcomings of *single measures* has driven the development of *multiple measures*. This development was drawing on the assumption that if adequate emphasis is placed on all aspects of a job individuals' efforts will not be distorted (Ridgway, 1956, p. 243). A study about the competition between Soviet industries highlights the use of long lists of measures to assess performance. Here, measures related to profits, quantity, quality, assortment and materials, while *campaigns* and *priorities* were used by the Soviet management to communicate the importance of key measures. Because (groups of) measures were not weighted, added or averaged, it was impossible to determine if the emphasis on *campaign* or *priority* measures led to a shift of effort from other measures (Ridgway, 1956, p. 244). Further to this, also American management authors have recognised the importance of *multiple measures.* For example, Peter Drucker refers to lists of measures including market standing, innovation, productivity, physical and financial resources, profitability, manager performance and development, worker performance and attitude as well as public responsibility (Ridgway, 1956, p. 245).

This brief review of the development of *multiple measures* highlights the emergence of the notion of a *balanced stress on objectives,* this being a "… theoretical condition under which an addition of effort or recourses would yield equally desirable results in overall performance, whether applied to production, quality, research, safety, public relations, or any other suggested areas (Ridgeway, 1956, p. 245). Such a condition requires a *balanced set of multiple measures* what is named a single overall *composite measure* of performance.

Weighting plays a pivotal role in the development of *composite measures*, as for example shown in the *A.I.M. management audit*, a system developed by the American Institute of Management (A.I.M.). Here, overall performance measurement was accomplished by attaching a numerical grade to each assessment criterion and totalling of the scores of each criterion to obtain a total score. Because application of *composite measures* no longer allows for the compensation of emphasis on one criterion by slackening the effort on another criteria, raising the *composite score* places the whole organisation under pressure (Ridgway, 1956, p. 246).

The review of the literature on *composite measures* does not so much contributes to knowledge about the technical aspects of measures – highlighting the advantages of a *balanced* emphasis on all measures of performance – but to knowledge about the motivational and behavioural aspects of *measures* – highlighting that the application of *composite measures* may lead to the emergence of the *ratchet principle*[10], by which fear for this *ratchet principle* motivates workers not to exceed quota for fear that their work would then be rerated.

In sum, the reviewed precedent literature on measures discloses that the inadequacy of *single measures* and their impact on (de)motivating individuals has a detrimental effect on improving performance - the original aim of measuring performance. The assumption that an adequate emphasis on all aspects of a job will avoid individuals' efforts being distorted has driven the

[10] "Ratchet principle = The use of current performance as a partial basis for setting future targets …" (Weltzman, 1980, p. 302).

development of *multiple measures*. The aim for a *balanced stress on objectives* has driven the further development into *composite measures*. Application of *composite measures* however, bears in itself the danger of the emergence of the *Ratchet principle* by which fear for this effect motivates workers not to exceed their quotas. After reviewing the literature about measurements in performance measurement systems it can be concluded that within the context of the abundance of performance measures to be found in the literature, the selection of performance measures remains a critical step by which the largeness and complexity of the performance measurement system in which the measures will be used make the selection more challenging.

An appreciation Porter's models and alternative performance measurement approaches in the corporate sector in relation to the objectives of the present research is presented in the following sub-section of this chapter.

2.3.11 Appreciation of Porter's Models and Alternative Approaches in Relation to the Objectives of the Research

What emerges from the sub-sections 2.3.2 to 2.3.10 of this chapter is used to inform the justification of a further investigation into the applicability of Porter's models to 'answer' the initial research question of this study. The outcome is based on the following considerations emerging from the review of the literature.

Porter's thesis as presented in his *The Competitive Advantage of Nations* stands out not least because of the reputation of its creator and the interest and reactions his work triggered. This, and the congruence of Porter's claim that his thesis explains "why … some social groups, economic institutions, and nations advance and prosper' (Porter, 1998, p. xxiii) with the objective of this study is justification for the decision to locate Porter's thesis at the heart of the literature review in this study.

Porter's diamond (1998, p. 173) depicts how the determinants as well as the dynamics between the determinants of competitiveness govern the extent to which the improvement and development of competitive advantage take place.

Moreover, the condition of the diamond is characteristic of the firm's stage of competitive development. The relevance for the present study as offered by the diamond model is that it makes it possible to determine the stage of competitive development on the basis of a few determinants while the four stages model of competitive development reflects the characteristic sources of advantage and the nature and extent of success.

Following the review of the international trade theory literature, Porter's *competitive advantage* paradigm essentially seems to be "… an informal integration of the comparative advantage theorem with elementary production theory" (Davies and Ellis, 2000, p. 1201). However, the relevance for the present study is not so much the novelty of his *competitive advantage* paradigm, but the fact that his proposition is well embedded in the established management/trade theory and is presented in an attractive way which makes his proposition appealing to the non-specialist. The criticism emerging from the literature to the effect that the notion true prosperity is only found in the *innovation-driven stage* is incorrect has relevance for this study. This will be considered further in the thesis. The empirical evidence presented in this literature review does not support Porter's claim that the advantages of clustering are based on "*… the exchange and flow of information about needs, techniques and technology among … related industries*" (Porter, 1998, p. 152) but suggests that explanations of collaborations draw on *urbanisation economies* rather than Porter's cluster theorem. The significance of the emergence of this flaw in Porter's reasoning for this study is that it is likely to result in empirical evidence being sought to confirm or reject this criticism. Here, the emergence of the limitations of the diamond model has resulted in the creation of extensions of Porter's diamond. However, the development of these extensions has also created two side effects: (1) the extended versions of the diamond have (in part) lost the compelling simplicity of the original diamond model; (2) the use of different models may yield different assessments for the same countries. As seen in the literature reviewed, the assessment of Germany with Porter's single diamond provided results closest to the median of all the versions of the diamond, and extensions of the diamond here are not considered further.

The articulation of measures in section 2.3.9 provides a reliable summary of what is written about measures in *The Competitive Advantage of Nations.* However "…the reader [is] none the wiser about how competitive advantage is to be defined, let along measured" (Davies and Ellis, 2000, p. 1194). Porter provides an abundance of attributes, measurements and indicators of competitive advantage, but most of these refer to intangible concepts. Here, the reviewed precedent literature on measures largely discloses how the inadequacy of *single measures* has driven the development into *multiple measures,* this being followed by the emergence of *composite measures*. Within that context, the diamond may be regarded as a *composite measure.* Furthermore, the review of the extant literature on performance measurement systems in the corporate sector clearly shows that there is no ready-to-use solution for the research problem in this study.

The aim of the following table is to establish a match between the objectives of this study and the most salient performance measurement approaches in the corporate sector.

Table 4: Match between the key objectives of this study and the most salient performance measurement approaches in the corporate sector

Key objective of this study	**Porter's models**	**Dashboard (Tableau de Bord / Balanced Scorecard) approaches**
Introduce 'best practices' from different domains in the higher education domain.	Drawing on the reputation of its creator and the interest and reactions his work triggered, Porter's thesis can be categorised as belonging to *best practices* in the corporate sector. Porter's proposition is in essence an informal integration of the comparative advantage theorem with elementary production theory being well embedded in the established management/trade theory.	The Tableau de Bord has been used for more than 50 years by companies (in France) for tracking and reporting multiple indicators, while the Balanced Scorecard has established itself as a powerful tool to help managers worldwide translate strategy into practice.
Improve the understanding of how university performance in research is created and developed to reach universities' strategic goals better.	In Porter's view, his thesis explains why particular social groups, economic institutions and nations advance and prosper.	The dashboard approach provides a better understanding of cause-effect relationships between actions and process performance.
Identify key measurements of university performance and explain their impact.	Porter provides an abundance of attributes, measurements and indicators of competitive advantage, but the reader is none the wiser about how competitive advantage can be defined, let alone measured. Empirical evidence about which measurements to use needs to be created.	Key measurements are not only limited to financial indicators, but also include operational measures. KPIs are created by translating vision and mission into a set of objectives from which key success factors can be identified. These are translated into quantitative KPIs that are largely controllable. The Balanced

		Scorecard proposes four generic sets of indicators related to the company’s finances, internal business processes, learning / growth and customers.
Provide (a) theoretical framework(s) for university performance.	The four stages of the competitive development model reflect the characteristic sources of advantage and the nature and extent of success.	The Dashboard framework comprises financial and non-financial indictors which are integrated into a nested structure (one for each sub-unit). Key characteristics of the framework are: there are few indicators providing a complete view of the company’s performance; there is a connection with the company’s information system which provides further detail; there is a grouping of the indicators in boxes, each capturing a distinct perspective of the company’s performance, but all of these are linked to vision and strategy. Here, quantitative data is used as a means to understand and improve the underlying activities.
Make a contribution to professional practice with a practical solution for the research problem	There is no shortage of explanations regarding competitiveness but these are often conflicting and there is no generally accepted theory. Porter’s theory provides managers with insights about how to make strategy more effective vis-à-vis international competitors. Porter’s models	Using a Tableau de Bord or Balanced Scorecard approach can help managers to bring about a sound strategy, providing a clear focus on key success factors and a strong alignment of energies. This is achieved by focusing on the firm’s progress with these elements.

	are presented in an attractive way which also makes them appealing to the non-specialist.	

The tabular presentation of the match between the most salient performance measurement systems in the corporate sector and the objectives of this study highlights how there is much congruence between Porter's thesis and the Dashboard approaches as with the Balanced Scorecard. Both would seem to explain causal relationships between actions and performance, thereby helping to reach the company's strategic goals more effectively. Porter's diamond and the Balanced Scorecard both offer a *composite measure* of the company's competitiveness where quantitative data is used as a means of understanding and improving the underlying operational activities. Porter is providing an abundance of measurements and indicators of competitive advantage but is leaving the reader none the wiser about how competitive advantage can be defined, let alone measured, whereas the Balanced Scorecard's four generic sets of indicators - relating to the company's finances, internal business processes, learning and growth and customers - appear to be less relevant for the present study which is situated in the higher education sector.

At this level, both approaches seem to offer equal opportunities to answer the research question, suggesting a comparative study to investigate the usefulness of each approach to answer the research question. Clearly, this study will improve from such an approach. However, careful consideration of the available resources revealed that this was not possible within the context of the present doctoral study without losing the focus and depth of the investigation. Within the context of a hiatus in consensus relating to the core theoretical foundations of performance measurement and the substantial theoretical framework presented by Porter in his *Competitive Advantage of Nations,* the intention is to further explore the application of Porter's models in higher education. Recommendation will also be made to conduct a similar investigation into the application of the Balanced Scorecard in higher education for further research. Here, the focus will be on was feasible within the limitations of this study.

A tabular summary of the precedent studies about performance measurement in the corporate sector is given in Appendix 1.

The following sections of this chapter present the precedent literature relating to performance measurement in the higher education sector.

2.4 Review of the Performance Measurement in the Higher Education Literature

This review of the literature on performance measurement in higher education focuses on the measurement of performance in *research*.

The aim of the critical assessment in this section of the chapter of the most salient performance measurement systems emerging from the extant literature on performance measurement in higher education is threefold: (1) to provide a clear articulation of Porter's models and of the most salient performance measurement systems used in higher education; (2) to evaluate Porter's models and their most salient alternatives; (3) to articulate an appreciation of Porter's models and alternative approaches in relation to the objectives of the research (Woodward-Kron, 2002, p. 125).

The criteria by which the performance measurement systems are judged can be expressed in the form of three questions: (1) How were the measurement systems developed? (2) What is the contribution of the measurement system to knowledge and professional practice? (3) Are the outcomes trustworthy?

The presentation of the findings in this section of the chapter is in the form of a *theoretical review* examining the body of work on measuring performance in the higher education sector. The preference for this approach is explained in section 2.1. This section commences by describing the context of performance measurement in higher education. This focuses on the origin of performance measurement in higher education, the ontological orientation and the economic philosophical context of the emergence of performance measurement in higher education. It also focuses on the impact of performance measurements on professional practice in higher education. The structure of the presentation in the sub-sections 2.4.3 to 2.4.7 places the application of Porter's models in higher education at the heart of the review and is then followed by an assessment of alternative performance measurement systems and measures that are used in higher education. This section of the chapter closes by making the match between the performance measurement systems and the measures reviewed in this section and the objectives of the study.

2.4.1 Origin, Ontological Orientation and Economic Philosophical Context of Measurement Systems

Measuring performance is not alien to higher education. Students at universities today owe their exams to the Jesuits who started in the 16th century to use tests for the evaluation of their students (Allen and Yen, 1979, p. 3). The origin of performance measurement in higher education can further be traced back to the 1760s with the development of the written examinations for the *Cambridge mathematical tripos*. Here, a student's success was recognised both as a mark of personal and institutional success, resulting in colleges attempting to prove that their candidates were the best and the emergence of a new morality in target setting (Strathern, 1997, p. 118). The writing, grading and examining practices of the educational world subsequently inspired the nineteenth century accounting practices in the business world where financial and human performance were combined into *human accounting* whereas these practices looped back into higher education alongside the emergence of neoliberalism in the 1980s and the second academic management revolution which took place from 1960 to 2000 in the United States. Here, faculty judgements and collegial readership were substituted for bibliometrics (Feller, 2002, p. 440). The introduction of performance measurement in higher education in the UK can be traced back to the Thatcher government in the early 1980s which saw the private sector as model of efficiency, and accountability as the technology being used to introduce the values and practices of the private sector into the public sector (Shore and Wright, 1999, p. 561). The corporate view on universities emerges from the following quote from the Jarratt report:

> *We stress that in our view universities are first and foremost corporate enterprises to which subsidiary units and individual academics are responsible and accountable. Failure to recognise this will weaken the institution and undermine its long term vitality*.

Excerpt from the Jarratt report, 1985, as cited in Kuehn, 2002, p. 114.

In the context of the Jarratt Report, universities are viewed as corporations where students are the customers and academics are subject to performance measurement, promoting discussions regarding cost efficiency and the targeting of research funding, etc. However, authors such as Glass, Hyndman and McKillop (1996, p. 59) criticise this stance by highlighting "...the dearth of empirical evidence to support these discussions".

The theoretical foundation of the trajectory by which "values cross from one domain of cultural life to another and then, in altered form, back again" (Strathern, 1997, p. 118) is found in the domain of anthropology and is referred to as *cultural replication*. In the present study, *altered form* refers to the fact that it is no longer students' performance that is measured but institutional performance.

Measuring performance is rooted in the objectivistic ontological orientation. Thus, measuring is regarded as the foundation of understanding. Lord Kelvin is quoted on the relationship between measuring and knowledge as saying:

> *In physical science the first essential step in the direction of learning any subject is to find principles of numerical reckoning and practicable methods for measuring some quality connected with it. I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the state of Science, whatever the matter may be.*

Kelvin, 1883, as cited in Paul, 2008, p. 325.

Here Lord Kelvin situates the objectivistic ontological orientation in the domain of the natural sciences. Using such an objectivistic approach in the social sciences however, implies that the researcher adheres to the stance that social phenomena have an almost tangible reality which is independent of social actors (Bryman, 2012, p. 33). However, capturing the intangible construct *performance* by measurable quantities is subject to an ongoing debate, as shown in the next sub-section of this chapter.

In sum, this sub-section of the chapter disclosed that measuring performance is in-part rooted in (higher) education which may explain the unrestrained expansion of performance measurement practices in that sector since the1980s. Further emerged from the reviewed literature that the transfer of performance measurement in the 1980s from the business domain into the higher education domain can be explained with the anthropological concept of *cultural replication.* However, whereas measuring performance is rooted in the objectivistic ontological orientation is such an approach in the social sciences subject to an ongoing debate.

In the following sub-section, the impact of performance measurement on professional practice in higher education is reviewed.

2.4.2 The Impact of Performance Measurement on Professional Practice

Emerging from the literature about the impact of performance measurement on professional practice in higher education is that the driving force behind the introduction of managerialism in higher education in the mid-1980s was “... the Government’s desire to expand outputs without a corresponding expansion of inputs” (Glass, Hyndman and McKillop, 1996, p. 59) and to ensure “... that optimum value is obtained from the use of resources, that policy objectives are clear, and that accountabilities are clear and monitored” (Kuehn, 2002, p. 113). Performance measurements based on evaluation of research outputs were employed as the tools to achieve that objective.

Here, the notion of a causal relationship between performance measurements and improved performance is drawing on the assumption that “… whatever is measured and reported tends to affect behaviour” (Glass, Hyndman and McKillop, 1996, p. 62). However, the consequential behavioural impact of using output measurements to measure performance can have a positive and negative influence on the success of using performance measurement to improve performance (Glass, Hyndman and McKillop, 1996, p. 62).

An analysis of the impacts of the 1989 and 1992 RAE’s on the assessed universities shows increasing average returns to scale in both periods, suggesting that the impact of the 1989 and 1992 RAEs on the university sector was an increased overall efficiency. However, segmenting the UK universities into top, middle and bottom subgroups based on the research score per member of academic staff, showed that while the RAE 1989 results indicated an increasing return of scale for all the subgroups, the RAE 1992 results only demonstrated significant increasing returns to scale for the top universities .This suggests that further efficiency improving investments only had an impact on the top universities. When examining the RAE 1989 results for research product-specific (dis)economies of scale showed the 1989 results economies of scale for all the subgroups whereas the RAE 1992 results showed product-specific diseconomies of scale for all the subgroups. A possible explanation is that "… too much targeting of research funding… occurred between 1989 and 1992" (Glass, Hyndman and McKillop, 1996, p. 63). However, an alternative explanation could be found in that "… there is a time lag between funding and output regarding research, and in time, additional research funding will yield additional quantity and quality in research" (Glass, Hyndman and McKillop, 1996, p. 63).

The relevance for the present study of the evaluation of the 1989 and 1992 RAE's is that it highlights the paucity of evidence (Cave and Weale, 1991, p. 6) to inform the discourse about cost efficiency of universities and targeting of research funding.

Examples of how methodological choices related to the design of performance measurement approaches impact consequential behaviour also emerged from the review of the literature. It was found that the choice of university *departments* as a Unit of Analysis (UoA) in research assessments affected the assessed science by obscuring important features of modern research and influencing the publishing behaviour of the researchers (Bourke and Butler, 1998, p. 711). This criticism of the use of *departments* for a Unit of Analysis in the Research Assessment Exercises is based on the assumption that within departments, research groups often have very little interaction with each other and that such research groups frequently cut across the boundaries of departmental and other academic structures (Bourke and Butler, 1998, p. 711). Empirical evidence for this assumption draws on the *citation outside* concept of Chubin whereby " ... the degree to which scientists cite findings outside their discipline specialty" is monitored (Bourke and Butler, 1998, p. 712). Empirical evidence of the *citation outside* concept is, for example, found in a study encompassing data on all Australian universities. That study explores how far the classification of research departments corresponds with the classification of the disciplines and sub-disciplines to which the researchers in these departments contributed with their publications. Depending on the field of science, the results showed that between 20% and 84% of the publications came from departments outside the field. An example of the obscuring impact of the *citation outside* concept is for example found in the practice of departments in a discipline with an average low *citation per publication* (ccp) rate, for example Mathematical Sciences with a ccp of 2.8, to publish relatively frequently outside their discipline, for example in the Physical Sciences with an ccp rate of 7.8, and thus compare favourably against departments that publish more within their own discipline (Bourke and Butler, 1998, p. 717).

The relevance for this research of the emergence of consequential behavioural impact caused by the choice of the Unit of Analysis (UoA) is the recognition that the departmental focus of the RAE-approach disadvantages interdisciplinary research and obscures the importance of intra- and trans-departmental groups. However, it should be recognised here that it is very difficult to develop a system-wide research evaluation exercise based on looser and shifting group structures. Use of field-coded research information might result in the development of a strategic mapping of research which can replace the departmental focus of the current RAE-approach.

Government attempts to introduce managerial technologies such as audits in universities have contributed to professional practice at a practical level via the emergence of a new category of staff in higher education, encompassing functionaries such as *educational development consultants, quality assurance officers, staff development trainers and teaching quality assessors* (Shore and Wright, 1999, p. 560). Attempts to introduce managerial technologies in universities on a strategic level created a shift of priorities from research and teaching to competitive wealth creation, greater links between scientists and business people and more responsiveness to industry, commerce and government (Shore and Wright, 1999, p. 563). This shift in priorities has impacted the professional practice of the scientist via the fragmentation of the scientist into *researcher, teacher* and administrator which has led to more working hours and increased stress for the scientists involved (Shore and Wright, 1999, p. 569).

Evidence of the assumption that varying strategic choices impact differences in the performance of German universities is provided by the results of a Data Envelopment Analysis using data from 73 public universities in Germany and aiming to identify if a strategic focus on research as opposed to a focus on education, or a focus on the natural sciences in contrast to a focus on the social sciences, led to a higher efficiency score. The results of the study showed that German universities indeed "… differ in strategic orientation indicated by differences in efficiency. It is greater in teaching than in research, and it is greater in the natural sciences than in the social sciences" (Warning, 2004, p. 406). The results further showed group formation of German universities based on efficiency. Interestingly emerged that the publication/graduation ratio (reflecting an orientation on research or teaching) did not influence performance significantly, but that the social sciences publications to total publications ratio was significantly impacting efficiency. Geographical location (either in the former West or East Germany) was also significantly impacting efficiency. Competitive environment and other static characteristics of the universities could not explain the presence of strategic groups based on performance.

The relevance for this study of highlighting the results of the DEA analysis of 73 public universities in Germany is that they provide evidence that differences in the performance of universities are the impact of varying strategic choices and that vice-versa universities with similar strategies also perform in a similar manner. This suggestion is congruent with the notion of *strategic performance-based groups* as introduced by Caves and Porter in 1977. This concept assumes that "within an industry firms with similar asset configurations pursue similar strategies with similar performance results" (Porter (1979) cited in Warning (2004) p. 394).

In conclusion to this sub-section of the chapter, it can be argued that comparing and contrasting the impact of performance measurement on professional practice in the corporate sector with its impact in the higher education sectors shows many congruencies. The desired impact in both sectors is an *improvement* in performance through *measuring* performance. However, it also emerged that many of the employed performance measurement frameworks in both sectors are based on an assumed understanding of the relationships between the object and its attributes to be measured and the measurements and indicators used, which is not further explained and thus casting doubt on the assumed understanding of these relationships. Additionally emerged that the selection of the most appropriate measurements is indeed the subject of ongoing debate in both sectors. Moreover, disagreement has emerged from the literature of both sectors as regards explanations for the same performance measurement related topics and issues.

2.4.3 Appreciation of Porter's Models

The aim of the following application of Porter's models in UK higher education was the development of an holistic understanding of departmental competiveness. For this purpose and inspired by their compelling logic in the late 2000s Porter's diamond and *four stages of competitive development* models were used to locate geography departments along a spectrum of development according to their competitive advantage vis-a-vis their peer group and drawing on the quantitative and qualitative outcomes of an assessment of their research (Curran, 2001). A detailed appreciation of the dataset and the exploration of the data used for the quantitative assessment of the competitiveness of the departments is given in sub-section 2.4.5 of this thesis.

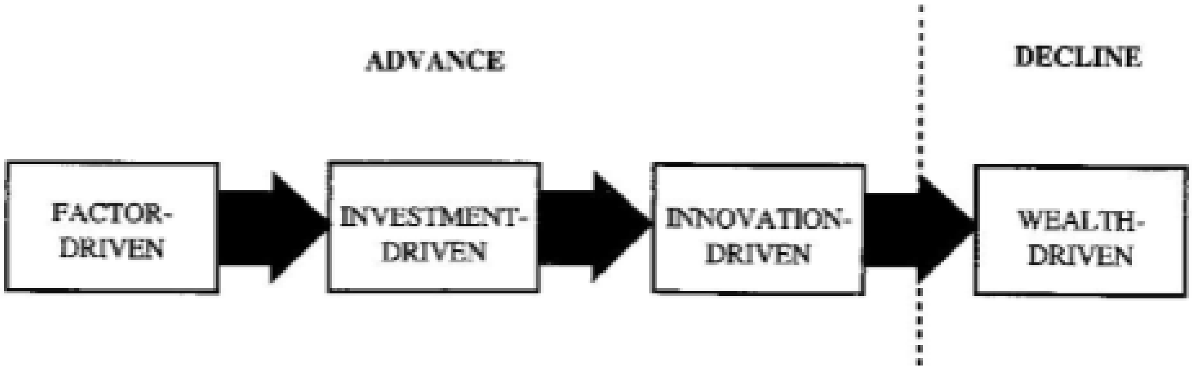
As presented in sub-section 2.4.5 the outcome of the quantitative assessment of the competitiveness of the departments provided four scatterplots depicting the competitiveness of each of the assessed departments vis-à-vis its competitors, by which the level of competitiveness was articulated as stronger RAE performance than expected, equal RAE performance as expected, and weaker RAE performance than expected. The relative condition of a department in each of the scatterplots corresponded with the condition of each of the corners of that department's diamond. For example, the diamond of a department with stronger RAE performance than expected on his *Factor conditions* but weaker RAE performance than expected on the corners *Departmental strategy, structure and rivalry, Demand conditions* and *Related and supporting departments conditions* is shown in Figure 22 and is characteristic for the *Factor-driven stage* of competitive development.

Figure 22: Porter's diamond in each of the four stages of competitive development

Curran, 2001, p. 247.

It was acknowledged that in UK higher education of the *four stages of competitive development* as depicted in Figure 23 the first three stages are associated with increasing RAE scores, whereas the fourth stage is one of ultimate decline.

Figure 23: Porter's four stages of competitive development model



Porter, 1998, p. 546.

It was found that departments in the *factor-driven* stage drew all their competitive advantage from their institution. In the *investment-driven* stage, the departments embraced change and invested aggressively in staff numbers and research facilities. The departments in this stage focused on research strengths and reduced areas of activity with the aim of upgrade their competitive position within the limitations of the available resources. It was recognised that characteristics of this stage included acceptance of change, benchmarking and instability, which all are alien to many academics. As another characteristic of this stage emerged that departments started to perform well on *demand*-based quantitative measures and used internal mechanisms to further encourage performance. In the *innovation-driven* stage, all the attributes of competitive advantage worked together to foster continuous self-reinforcing innovation. In this stage departments were less dependent of their parent institution and had expanded their planning horizon from an annual view into a long-term view. Departments in this stage dominated the national stage and attracted like a magnet excellent researchers, post- and undergraduates and research funding, the latter not only being used for further investment in the departments themselves but also in collaborating departments, thus promoting the establishment of strong interdepartmental research clusters. The culture in this stage was one of risk taking and foraying into new areas of research, applying for the most competitive funding opportunities, determining the (inter-)national research agenda, and publishing in the most demanding journals. In the *wealth-driven* stage the driving force was provided by staffing and facilities achieved in a previous stage of competitive development, whereas the culture in this stage had turned into one of complacency, lack of competitive vitality and increasing emphasis on the redistribution of wealth, ultimately leading to genteel decline of competitiveness (Curran, 2001, pp. 245-248).

The relevance of the identification of the characteristics of each stage of competitive development is that the characteristics of each subsequent stage provide the goals for upgrading from the previous stage. Further was directional for this study Curran's confirmation that Porter's thesis helps to model the competitive environment that universities face since the introduction of competitive funding mechanisms and the recognition that Porter's models are conceptualised around departmental, institutional and national levels, which makes Porters model suitable for use in this study using the university as Unit of Analysis. Despite its demonstrated usefulness for application in higher education emerges from the review of the literature in the next section of this chapter that use of Porter's model in higher education is more an exception than a rule. As a consequence acknowledges Curran that further research is required to evaluate the utility of Porter's models in higher education and into the different measures to be used by which Curran anticipates further refinement or reformulation of the model (Curran, 2001, p. 249). This appeal for further research into the application of Porter's models in higher education also provides further legitimation for the present research.

2.4.4 Appreciation of Alternative Performance Measurement Models

As already mentioned in the previous sub-section the application of Porter's models in higher education is more exception than rule. Emerging from the literature on performance measurement systems used in higher education is the ubiquitous presence of the British *Research Assessment Exercise* (RAE) - now *Research Excellence Framework* (REF) - model.

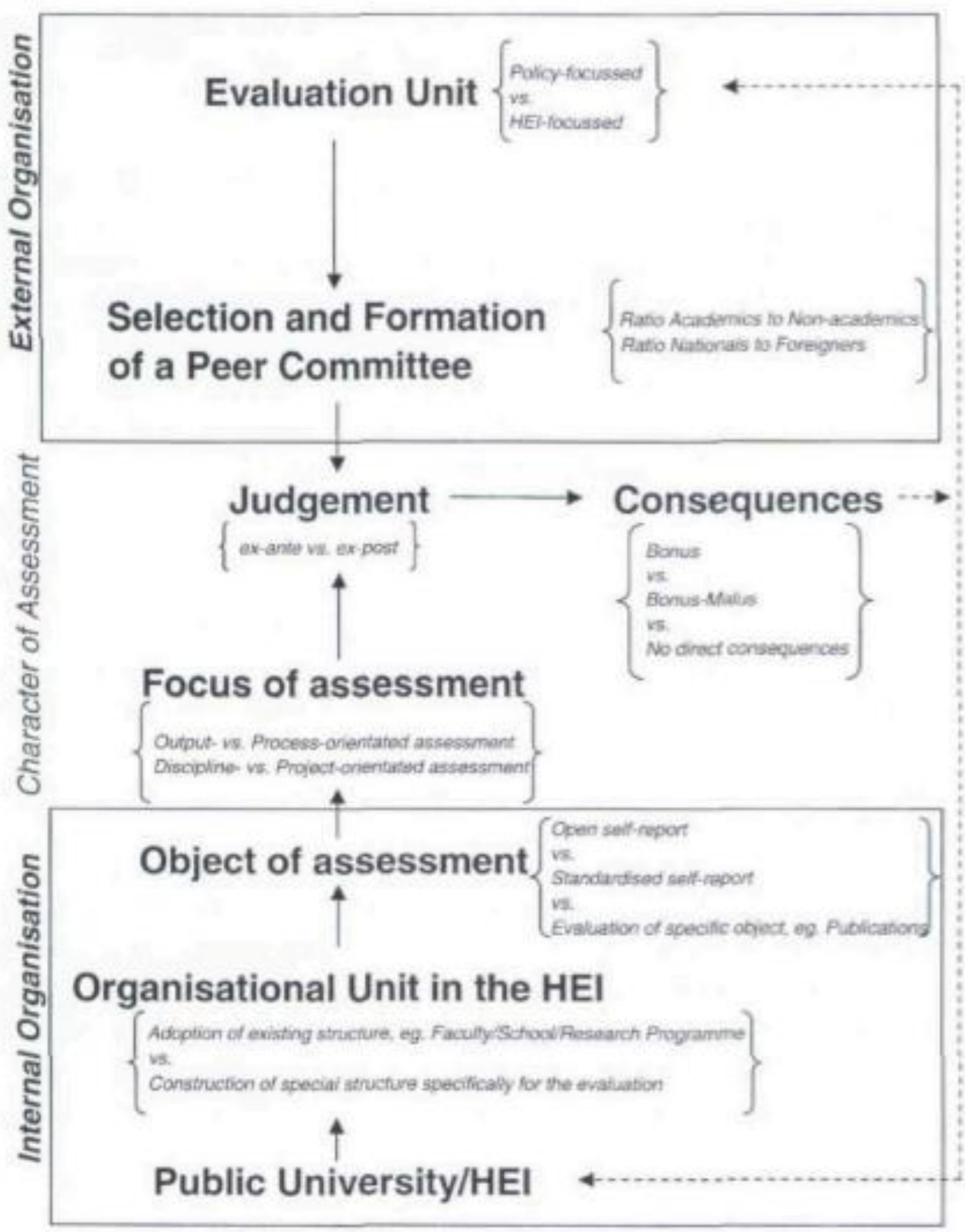
The *Research Assessment Exercise* has been regularly used in the United Kingdom by the Universities' Funding Council (UFC) and its successor, the Higher Education Funding Council for England (HEFCE) since 1986 and provided a major impetus for performance measurement in higher education.

The RAEs introduced an “explicit and formalised assessment process of the quality of research” (RAE, no date). The assessment of the works submitted to the exercise was carried out using a two-tier panel system. This consisted of sub-panels staffed by experts drawn from higher education institutes and the wider research community, as well as main panels with international members to ensure that “international standards were maintained consistently across the exercise” (RAE, no date).

The RAE model has been developed in the public sector for the purpose of assessing research performance based on empirical evidence. Its contribution to the domain of performance measurement in higher education is that the RAE model developed into the archetype of research assessment approaches and it has now been adopted by many countries. Evidence from various research fields confirmed that the rankings awarded by its panel system were reasonable and realistic. However, as a weakness of the RAE model emerged that the use of panels made the exercises very costly: “millions of pounds were spent on the 1992 RAE” (Oppenheim, 1995, p. 25).

The RAE approach and its adaptations in the Netherlands, Ireland and Germany can be synthesised in a conceptual framework for research assessment design as depicted in Figure 24.

Figure 24: Conceptual framework for research assessment design



Orr, 2004, p. 353 (Limited quality of the figure due to the original document).

The design options as emerging from the review of the approaches in the four countries and included in the conceptual framework encompass three broad categories: (1) the organisational structures and processes *outside* the universities; (2) the preparatory activities and coordination *within* the universities; (3) the resulting judgements and their consequences (Orr, 2004, p. 352). The seven key elements included in the conceptual framework are: (1) *Evaluation unit* – near to the government vs near to the higher education institutes; (2) *Selection and Formation of peer committee* – scientific vs other, and local vs foreign members; (3) *Object of the assessment* – open or standard self-report or specific object evaluation; (4) *Internal organisational unit* – adoption of existing structure or construction of special structure; (5) *Focus of the assessment* – discipline vs project focus, or output vs process focus; (6) *Judgement* – ex-ante or ex-post; (7) Beneficial *Consequences* of the assessment – none, bonus or malus (Orr, 2004, pp. 352-359).

In addition to Porter's models, also some other performance measurement frameworks and models used to assess research performance in higher education have moved from the corporate sector in to the higher education sector, among the more salient of these are the *Two-input-three-output model* and *Data Envelopment Analysis*.

The 'Two-input, three-output cost function model' was developed in 1996 to establish the theoretical construct from which to analyse the cost efficiency of universities:

$$C = f\,(P_1, P_2, Q_1, Q_2, Q_3)$$

In this model, C constitutes the total costs, P_1 and P_2 were the costs of the two inputs of capital and labour, and Q_1, Q_2, and Q_3 were the three outputs: undergraduate teaching, postgraduate teaching and research (Glass, Hyndman and McKillop, 1996, p. 61).

The 'Two-input, three-output cost function model' presents a more conceptual than operational contribution to professional practice drawing on the "Government's desire to expand outputs without a corresponding expansion of inputs" (Glass, Hyndman and McKillop, 1996, p. 59) and on the assumption that decisions founded in rational analysis are effective and efficient. The study by Glass et al. further addresses a number of generic issues related to performance measurement that were presented earlier in this chapter, including: difficulties inherent in the choice of output measures, consequential behavioural impact and the suggestion to use a *composite* model.

Empirical evidence of the applicability of two of the earlier discussed (Section 2.3.8) performance measurement systems: (1) the Dashboard (Tableau de Bord) PMS; (2) the Performance Prism, in higher education is emerging from a case study aiming to understand how the choice of Performance Measurement System (PMS) influences the desired outcomes at a large North-eastern University in the US (Smulowitz, 2015). First, the case study in its review of the literature explains the scarcity of successful assessment and PMS in higher education by drawing on the concept of *coupled* systems, highlighting that higher education institutions as *loosely coupled systems* have a distinction from *tightly coupled systems* such as traditional industries. The characteristics of *loosely coupled systems* include: (1) physical separateness – many departments of a university are on different locations; (2) independence from the central area of authority – most academic bodies are managed by a Dean or Chairperson; (3) isolation from others – departmental changes have little or no effect on other departments within the university; (4) unique identity – each academic area has a specialty in knowledge; (5) multitude of methods for reaching the same goal - each faculty member has the autonomy to teach and research in her/his own way; (6) great emphasis on social construction of reality – departmental members have stronger ties to their departments as to the overall institution. The explanation emerging from the review of the literature in the case study is that it is because of the nature of *loosely coupled systems* that "… assessment and PMS as well as many other changes, have taken so long to move through institutions of higher education" (Smulowitz, 2015, pp. 71-72).

The case study further highlights that the Dashboard (Tableau de Bord) PMS requires that members of the different departments must be clearly aware of the intended outcomes otherwise this can lead to "… multiple perceptions of the outcomes for various organizational members" (Smulowitz, 2015, p. 74). The drastic differences in the perception of the outcomes of the use of the dashboard (Tableau de Bord) PMS in a planned organisational strategy as emerging from 32 in-depth interviews held with employees at several levels of this university comprise: (1) perceived lack of involvement and awareness about the dashboard (Tableau de Bord) PMS effort by members of the departments – senior leaders underestimated the importance that university members placed on being involved and aware; (2) disparity in understanding the goal of using the dashboard PMS – some members of the organisation became irritated and perceived the use of the dashboard PMS as a failure; (3) concern about the availability of resources – senior leaders underestimated the importance of providing directors and staff members with additional resources to implement the application of the dashboard PMS (Smulowitz, 2015, p. 76). From the interview responses further emerged that the dashboard (Tableau de Bord) PMS ignored the stakeholders' *wants-and-needs* which led to the major disparities in understanding the goal of the effort which may have been prevented by applying the performance Prism PMS, the latter because its stakeholders focus. Confronting the outcomes of the case study with the components of the Performance Prism PMS reveals opportunities for the use of the latter in three major areas: (1) stakeholder satisfaction – "who are the stakeholders and what do they want and need?" (Neely, 2001, as cited in Smulowitz, 2015, p. 77); (2) stakeholder strategies – "what are the strategies required to ensure the wants and needs of the stakeholders are satisfied?" (Neely, 2001, as cited in Smulowitz, 2015, p. 77); (3) stakeholder contribution – "what contributions does the organization need from its stakeholders?" (Neely, 2001, as cited in Smulowitz, 2015, p. 78). It is suggested that use of the Performance Prism PMS would have led to (1) the examination and addressing of all stakeholders *wants-and-needs*; (2) the emergence of KPI's which enable all stakeholders to monitor, analyse and manage the progress of using the PMS; (3) the disclosure of the needed contributions of all stakeholders and the setting of their expectations. However, it must be acknowledged here that so far no papers about the use of this novel PMS in higher education were found in the literature (Scopus, no date).

Data Envelopment Analysis (DEA) is a methodology used in the corporate sector for analysing relative efficiency and managerial performance. This method makes it possible to determine the most efficient performer as benchmark and to measure the performance of other performers relative to the benchmark. Here, DEA provides an alternative to regression analysis, its main advantage being that it constructs the benchmark solely on the basis of observations (Jemric and Vujcic, 2002, pp. 174-175). Used in higher education, this method enables university decision makers to allocate their resources more efficiently (Korhonen, Tainio and Wallenius, 2001). It also provides the opportunity to *scientifically* (within an objectivistic ontological orientation) evaluate research performance. DEA was for example used to assess the performance at the Helsinki school of economics in a three step process including: (1) definition of criteria and indicators to measure the research performance; (2) collection of appropriate data from the assessed units; (3) calculation of *value efficiency scores* which indicated how much the assessed units had to improve their performance to obtain the same value as the *ideal* research unit. The latter was defined as:

> *A research unit whose members continuously produce high quality, innovative and internationally recognised research, and who actively supervise doctoral students and actively take part in various activities of the scientific community*

Korhonen, Tainio and Wallenius, 2001, pp. 123.

The trustworthiness of DEA is drawing on evidence emerging from the wide-spread application of this technique to evaluate the efficiency of production processes in the corporate sector, whereas the use of DEA to evaluate performance in higher education is also nothing novel (Korhonen, Tainio and Wallenius, 2001, pp. 126). The literature on *frontier efficiency analysis* and more specific on DEA in higher education shows a particular high occurrence of studies in the United Kingdom, Australia, Germany and Italy. The picture that emerges from analysis of these studies is that *frontier efficiency analysis* in general and DEA in particular in higher education provides "… a single efficiency score that integrates a large amount of information and thus facilitates assessments and comparisons" (Nigsch and Schenker-Wicki, 2015, p. 166). Among the strengths of DEA is that this method "allows for more differentiation among universities, taking in account existing diversity in terms of relative size and recourses or with respect to an institution's focus …"(Nigsch and Schenker-Wicki, 2015, p. 166). Among the weaknesses of DEA is that this method "… only delivers information about the variables included in the analysis, and strongly depends on the data used. It does not give a comprehensive reflection of the overall performance of such complex organizations as universities." (Nigsch and Schenker-Wicki, 2015, p. 166). Critical for the value of using DEA to evaluate academic research is to "find a set of criteria relevant for all universities [and] to find a set of indicators for each criterion" (Korhonen, Tainio and Wallenius, 2001, pp. 131). An additional weakness of DEA is that the efficiency scores are always in relation to the best performers and do not provide an absolute measurement and that efficiency scores are likely to vary across scientific disciplines. On a more meta level can be concluded from reviewing the literature on DEA in higher education that prudence is required when drawing conclusions or policy implications based on purely quantitative indicators. It is advised to supplement quantitative efficiency results with qualitative data on universities and their context (Nigsch and Schenker-Wicki, 2015, p. 167).

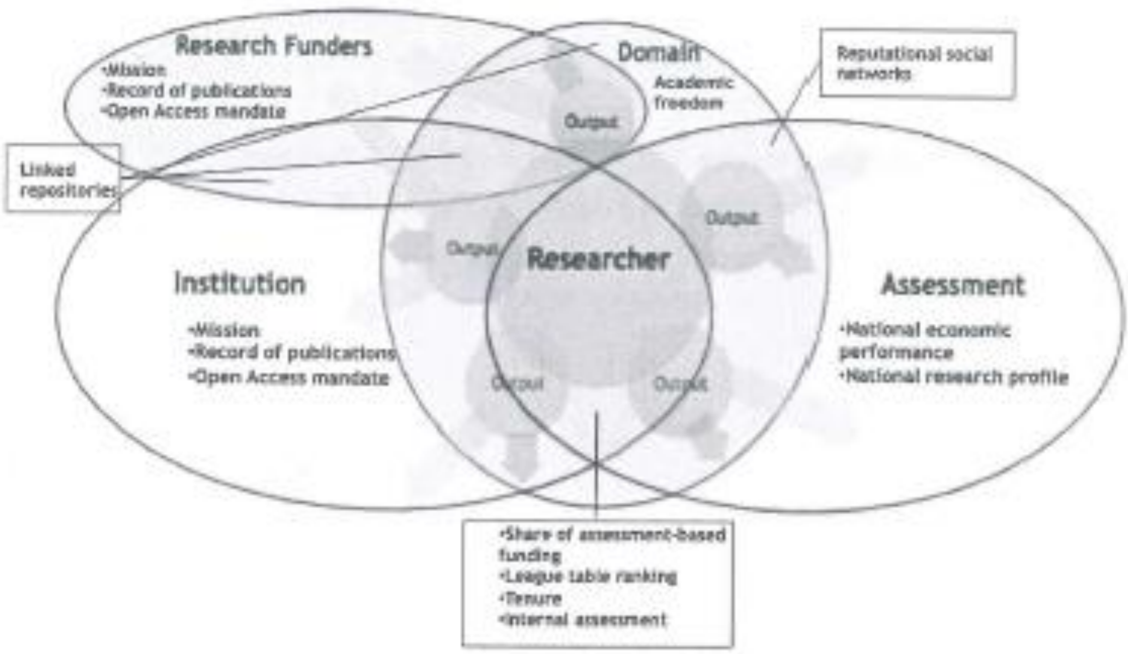
From the review of the extant literature on performance measurement in higher education also emerged performance frameworks and models which have not been derived from the corporate sector, amongst these: the Triennial Research Evaluation framework (VTR); the Research environment model; the Conceptual model of dimensions of research performance.

The Triennial Research Evaluation (VTR) which was completed in 2006 was the first national research assessment exercise in Italy. In contrast to the RAE in the UK, which encompassed the peer review of about 50% (200,000 outputs) of the total research output of the evaluated institutions at a cost of about €20 m per exercise (=about €100 per unit output), included the VTR only about 14% (18,000 outputs) of the total research output of the assessed institutions at a cost of about €3.5 m (=about €200 per unit output).

The results of the VTR assessment were used in a case study comparing the peer review approach of the VTR with a bibliometric approach (Abramo, D'Angelo and Caprasecca, 2009). A key finding emerging from comparing the results of the peer review exercise in VTR with the rating of the same universities using a bibliometric approach "reveal[s in the hard sciences] a significant overlap in the results of the two approaches … the two methods are substantially equivalent [however it was also found that] … differences in cost and times to execute the evaluations would certainly be relevant" (Abramo, D'Angelo and Caprasecca, 2009, p. 214). The comparative study however highlights as limitation of its findings that in the Arts & Humanities, in Law and in-part in Socio-economic areas journal publications are not the common format for the dissemination of research findings and that therefore "… the peer review approach thus remains difficult to substitute" (Abramo, D'Angelo and Caprasecca, 2009, p. 214).

The *Research environment model,* as shown in Figure 25, is a conceptual framework depicting the relationship between the researcher and assessments in the research environment.

Figure 25: Research environment model



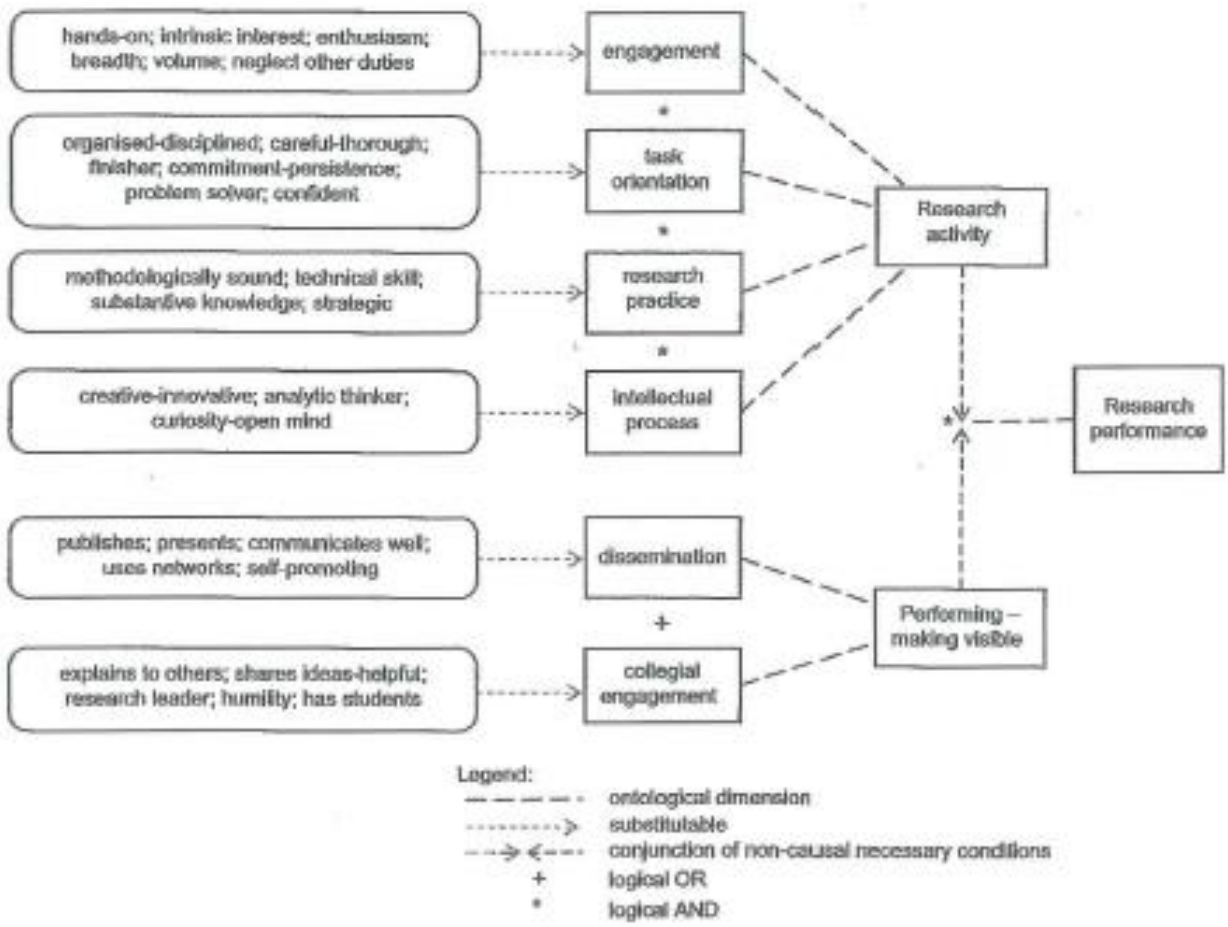
MacColl, 2010, p. 153.

The *research environment model* comprises four overlapping *environments*: (1) the Domain; (2) Research Funders; (3) the Institution; (4) Assessment. The environment *Domain* is the environment of *Academic Freedom*, this being the natural environment of academe where research is being carried out, breaking new ground and gaining the researcher a reputation and credit. In this environment, social networks such as *Nature Network* or *Mendeley* play an increasing role in helping academe build networks and expand its reputation through participation in informal group discussions and linking to drafts and research papers. Conducting research requires (additional) funding bringing researchers into the environment of *Research Funders* which is populated by governmental and private funders, the latter including charities and commercial organisations. Here, the overlap between *Domain* and *Research Funders* is where the *Researcher*'s grant proposal must meet the *Research Funder'*s mission. Researchers depend on their *Institution* for their salary and other intellectual benefits, while many institutions also partially fund research. In this environment, the *Institution* pursues its own mission. However, in those countries where research is significantly funded from taxpayers' money, governments increasingly require the beneficiaries to account for their expenditure and to demonstrate value to the tax payer; this being depicted by the environment of *Assessment* (MacColl, 2010, pp. 153-155 and 166).

A relevant addition by the *Research environment model* to what is already known is that the model depicts the overlap of the various environments in higher education which aids the exploration of opportunities for *Linkages*. It should be noted here that Porter asserts on the topic of *linkages* that "*linkages* occur when the way one activity is performed affects the cost or effectiveness of other activities" and that the "careful management of linkages can be a decisive source of competitive advantage "(Porter, 1998, pp. 41-42). The study for the *Research environment model* further found that in Australia and Denmark there was a strong emphasis on bibliometric measures driven by the desire to save assessment costs (MacColl, 2010, p. 159).

The *Conceptual model of the dimensions of research performance* is an empirical- based theoretical concept of research performance developed on the basis of responses from 295 teaching academics across all the departments of three Australian universities.

Figure 26: Conceptual model of the dimensions of research performance



Bazeley, 2010, p. 897.

Noteworthy in this model is the assumption that *Performing – making* [research] *visible* is recognised as one of the two key components of *Research performance*. One of the two elements of *making* [research] *visible* to others is *dissemination,* by which *publishing* is recognised as the most prominent form of *making* [research] *visible*, followed by *collegial engagement*. Not included in Figure 26, but emerging from the study, are the three broad classes of research outcomes: (1) *product* – generally some kind of publication; (2) *impact* on others - the latter being either academe, industry or society; (3) the enhancement of the *reputation* of the researcher - creating esteem and further funding opportunities (Bazeley, 2010, pp. 897-899).

Here, the contribution to professional practice is that the model provides a basis for challenging, extending and rebuilding outcome-focussed models" by which "… the dimensions and indicators identified in this study could have particular relevance at the … level of assessment, when the … status of an academic, department or centre is being determined" (Bazeley, 2010, p. 900). A limitation of the study is that to empirically test the need for the dimensions and the indicators highlighted in the model further data is required.

A summary of the contribution to knowledge by the review of the key performance measurement frameworks in higher education literature in this sub-section of the chapter and classified into the three criteria used to critically review the presented frameworks is presented in Table 5.

Table 5: Tabular summary of the review of the literature on performance measurement frameworks in higher education

Development	**Contribution to professional practice**	**Trustworthiness**
RAE/REF-approach develops into the archetype of research assessment. Critique on costliness of the panel peer review.		Evidence from various research fields confirms that the outcomes are reasonable and realistic.
Application of quantitative frameworks derived from the corporate sector.	Recommendation for the application of *composite measures* to avoid the consequential behavioural impacts.	
Porter's four stages model helps to quantify meta-activities of departments and universities	Offering a positive and constructive role for universities to increase competitiveness.	Drawing on a four year study of ten important trading nations.
DEA offers an alternative to regression analysis. Emerging	DEA helps to determine the most efficient performer and to use it	DEA is wide-spread in the corporate sector to analyse the relative

weakness is the difficulty to find relevant criteria and indicators for each criterion to be analysed.	as benchmark, allows to evaluate research performance within the objectivistic-ontological orientation and enables to develop common standards for evaluating academic research.	efficiency and managerial performance and its use to evaluate research is also not a novelty.
Substitution of the peer review RAE/REF-approach in Italy's VTR by use of bibliometric indicators.	The two approaches yield substantially equivalent results, however, significant differences in cost and time emerged.	Findings only valid for the *hard sciences* where journal publication is the common format of research output.
Development of a conceptual model depicting the relationship between researcher and assessment: development of the *Research environment model*.	The model aids the exploration of the opportunities for *linkages* which can be a decisive source of competitiveness.	
Development of the empirical-based *Conceptual model of research performance*.	Dimensions and indicators identified could have particular relevance for challenging, extending and rebuilding of outcome focused models .	Based on the responses of 295 teaching academics. The need to empirically test in further research of the dimensions and the indicators to be included.

Introduction of the stakeholder perspective in PMS: development of the *Performance Prism.*	Explanation of the scarcity of successful assessments and PMS in higher education explained with the *coupled systems* concept whereby universities are classified as *loosely coupled systems.*	Dashboard (Tableau de Bord) PMS require different indicators for different departments within the assessed university. Ignoring stakeholders needs lead to major disparities in achieving the goals of introducing performance measurement.

Emerging from the review of performance measurement systems used in higher education in this sub-section of the chapter is the dichotomy in approaches to measure performance in higher education - qualitative (peer review) and quantitative (bibliometrics). Here, decisions regarding qualitative or quantitative performance measurement approaches must be related back to the ultimate purpose and the context of the procedure, by which it should be emphasised that quantifying research performance entails a high reduction in qualitative differences (Orr, 2004, p. 360). These findings offer a challenge for the present research to synthesise a qualitative and quantitative performance measurement approach into a mixed approach, by which *a composite measurement* explains the impact of the measurements and indicators on the condition of university competitive advantage generated by research drawing on an understanding of the origin and development of university competitive advantage generated by research.

Research outputs, their measurements and indicators as used to establish the condition of competitive advantage generated by research are the subject of the next two sub-sections of this chapter.

2.4.5 Articulation of Measures in the Diamond

The approach taken while applying Porter's diamond to assess the performance of Geography departments in the UK (see also section 2.4.3) to select variables to represent each of the four corners of the diamond was difficult because: (1) no strong causal relationship between a *single* variable and any of the four corners could be established - suggesting the application of *many* variables; (2) strong intercorrelation existed between related variables - suggesting the use of *few* variables. This dualism led to the decision to select two variables to represent each corner of the diamond. For this purpose an initial dataset of thirty-six departmental and institutional variables[11] from twenty-eight different sources was tested – about half of these derived from the HEFCE 1996 RAE database (Curran, 2001, p. 225).

The dataset used comprised: (1) 13 *institutional variables* to represent the corner *factor conditions*; (2) 6 *departmental* variables to represent the corner *demand conditions*; (3) 6 *institutional* variables to represent *related and supporting departments conditions*; (4) 11 *departmental* variables to represent *strategy, structure and rivalry conditions*. The quantification of the absolute performance of each of the geography departments was by the indicator *staff weighted grade (swgd)*

swgd = (RAE rated grade X FTE category A academic staff)/FTE total academic staff

Curran, 201, p. 225.

Three of the 13 variables representing the corner *factor conditions* represented *Basic factors* – factors inherited by the institution as for example location – comprising: (1) population at location; (2) cost of housing; (3) attractiveness of location. The ten other factors represented *Advanced factors* – factors created by investments over time and most relevant for competitive advantage – comprising: (1) teaching/research ratio; (2) library investment per student; (3) size of the institution; (4) financial strength; (5) research orientation; (6)

[11] Variable: "a property of an object or event that can take on different values" (Howell, 2010, p. 4).

institutional assets; (7) total institutional income; (8) institutional income from HEFCE; (9) ratio of total income to grants, endowments and interest on investments; (10) 'bottom line' balance – a surrogate for the standard financial measure ROI. Of the tested variables for those related to location, financial health and degree of self-investment no meaningful relationship with performance of the department as expressed by RAE grade could be found (Curran, 2001, p. 228).

The 6 *departmental* variables to represent the corner *demand conditions* comprised (1) the proportion of the department's submitted publications that appeared as books, book chapters or as papers in journals; (2) income from all funders; (3) funding from Research Councils; (4) number of research fellows, assistants and research students; (5) ratio of research students to research staff; (6) number of Research Council funded research students. All of these variables showed some - sometimes weak - relationship with performance of the department as expressed by RAE grade whereas was found that the measure *proportion of the department's submitted publications that appeared as books, book chapters or as papers in journals* was not discriminating (Curran, 2001, p. 232).

The 6 *institutional* variables to represent *related and supporting departments* conditions comprised (1) *Times High Education Supplement (1996) staff weighted grade of all departments*; (2) proportion of research active staff; (3) proportion of research active staff with an RAE grade > 4; (4) proportion of research active staff with an RAE grade of 5*; (5) geography related departments with an RAE grade > 4; (6) geography related departments with an RAE grade of 5*. All of these variables showed some relationship with performance of the department as expressed by RAE grade whereas was found that the relationship appeared to be stronger for the lower grades (Curran, 2001, p. 232).

The 11 *departmental* variables to represent *strategy, structure and rivalry* conditions comprised: (1) departmental size; (2) number of undergraduate and research students; (3) ratio students to staff; (4) ratio support staff, research fellows, -assistants and -students associated to research staff; (5) ratio research support staff to research staff; (6) degree to which research studentships were funded internally; (7) doctoral degrees awarded; (8) degree of journal articles to all publications; (9) ratio RAE publication submission to all publication submissions; (10) change of research staff 1992-1996 RAEs; (11) academic staff with > 10 citations per year. Of these variables showed the *ratio students to staff, change of research staff 1992-1996 RAEs, ratio RAE publication submission to all publication submissions* no relationship with performance of the department as expressed by RAE grade (Curran, 2001, pp. 232 and 237).

In this UK study, from the results of a principal components analysis emerged that at least 90% of the variability resided in thirteen dimensions (1/3 of all tested variables). The first three of these (8% of all tested variables) accounted for 53% of the variability and were all related to the parent-institute and not to the assessed department. Strong relationships with absolute departmental performance was found for variables representing: research orientation; size and income; the demand for departmental expertise; strength in research provided by clusters of successful departments; departmental size, number of *academic stars*; focus on attracting funding and graduating research students (Curran, 2001, pp. 237 and 241).

In this UK study a stepwise multiple regression analysis was used to select the best two variables to represent each corner of the diamond. The eight resulting variables were: *Log. teaching to research funding* and *Total assets minus total liabilities* to represent the corner *Factor conditions*; the *Ratio of annual external income to research active academic staff* and the *Ratio of research students to research active staff* to represent the corner *Demand conditions*; the *Staff weighted grade of all the departments in an institution* and the *Percentage of departments in the institution connected to geography with an RAE grade of 5** to represent the corner *Related and supporting departments* conditions; the *Doctoral degrees awarded* and the *Ratio of journal articles to all publications submitted* to represent the corner *Departmental strategy, structure and rivalry conditions* (Curran, 2001, p. 243). Drawing on the R-squares of the four regression equations as shown in Table 6, suggest the outcomes of the multiple regression analyses that all corners of the diamond contribute about equally to the overall performance of a research department with explained variance ranging from 63% to 70%.

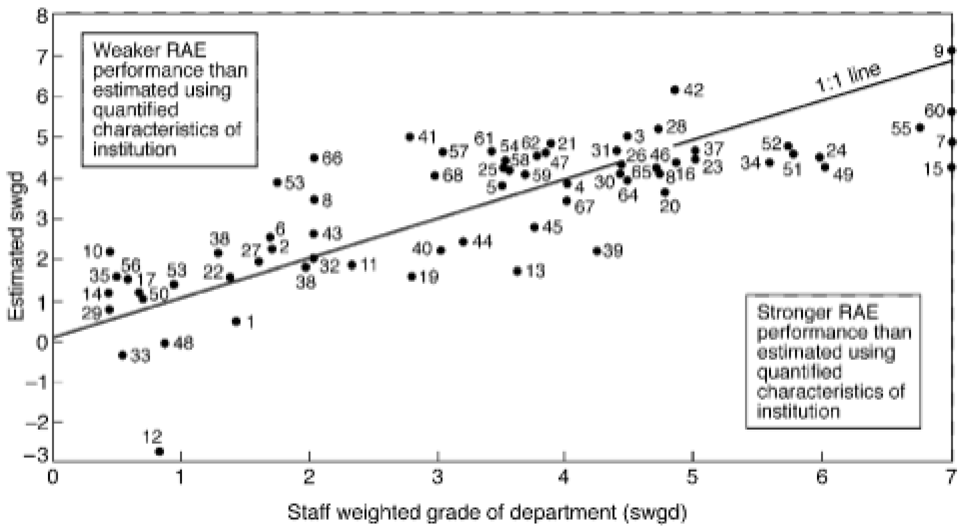
Table 6: Contribution of each corner to the condition of the diamond

Corner of the diamond	R square
Departmental strategy, structure and rivalry conditions	0.70
Demand conditions	0.68
Related and supporting departments	0.65
Factor conditions	0.63

Curran, 2001, p. 243.

The regression equations for each corner of the diamond, each including a pair of resulting variables, were used to calculate an estimation of the performance of each department in the sample for each corner of the diamond and this was followed by plotting the actual performance against the estimated performance for each corner, as shown in Figure 27.

Figure 27: Scatterplot of the actual and estimated performance for corner Factor conditions.



Curran, 2001, p. 243.

Figure 27 depicts research departments which perform more weakly than their peers, their actual performance (swgd) being less than their estimated performance (estimated swgd), these being above the regression line. Those performing more strongly than their peers are below the regression line.

The relevance of the UK study for the present research is that is demonstrated that the condition of the competitiveness of a research department can be established with help of Porter's diamond model following a sequence including a few steps:

1. Creation of a list of the most probable variables for each corner of the diamond;
2. Application of stepwise multiple regression analysis to determine the two variables to represent each of the four corners of the diamond;
3. Formulation of regression equations for each of the four corners of the diamond on the basis of the outcomes of the stepwise multiple regression analyses;
4. Calculation of the estimated performance with help of the regression equations;
5. Creation of plots, capturing the estimated performance and actual performance of all sample members for each of the corners of the diamond;
6. Establishment of the relative condition of each corner of the diamond of a sample member on the basis of the approximate positions in the plots;
7. Synthesising the diamond of a sample member through combining the four corners of a sample member.

The methodology employed in the UK study encompassing standard statistical methods and the congruence of the outcomes of the study with RAE ratings provide a solid basis for the trustworthiness of this approach.

2.4.6 Articulation of Alternative Measures

The development of criteria to assess research performance is nothing new in higher education. Martin and Irvin (1983, p. 62) for example, highlight that already in the 1960s the distinction between *internal* and *external* criteria appeared in the literature:

Internal criteria are generated within the scientific field itself and answer the question: How well is the science done? External criteria are generated outside the scientific field and answer the question: Why pursue this particular science? .

The need for suitable criteria to assess research performance increased in importance during the economic recession in the 1970s and increased further with the emergence of neoliberalism in the public sector since the 1980s.

One of the first empirical studies in research performance assessing the performance of four radio astronomy observatories in the UK in the early 1980s employed *converging partial indicators*[12]*.* Fairly consistent results were obtained with the following four indicators: (1) number of highly cited papers; (2) peer evaluation; (2) publications per researcher; (4) citations per paper. In this study, *past* performance was assessed because "… past performance, although by no means the only factor, is one of the best indicators of future performance" (Martin and Irvine, 1983, p. 88). The relevance for this study is that could be concluded that the method of using *converging partial indicators* was useful to science policy-makers, helping them to formulate an explicit science policy (Martin and Irvine, 1983, p. 61). The trustworthiness of the method of employing *converging partial indicators* is drawing on the "high degree of consistency between the results obtained with four of the partial indicators" (Martin and Irvine, 1983, p. 87).

In the early 1990s, academic institutions in several countries, for example the *Observatoire des Sciences et de Techniques* (OST) in France and the NOWT in The Netherlands, were established to provide the data, to develop indicators and systems and to perform the quantitative analyses of each nation's science system. However, until the mid-2000s the only provider of data used in these quantitative analyses was the Institute of Scientific Information (ISI)[13]. This is the publisher of the *Web of Science,* a large, multidisciplinary abstract and citation database, as well as a number of readily available analytical (bibliometric) tools. One of ISI's best known bibliometric indicators is the *Journal Impact Factor*. However, critics of this proprietary metric maintain that "... the

[12] Indicator: something that is devised or already exists and that is employed as though it were a measure of a concept – an indirect measure of a concept (Bryman, 2012, p. 164).
[13] Institute of Scientific Information (ISI) now part of Thomson Reuters.

methodological and operational origins are concealed from the end user who is not able to reflect on the theoretical assumptions implied in their construction" and convey their concern that "... a commercial company … holds a virtual world monopoly [on data that] structures political decisions affecting research systems all over the world..." (Weingart, 2005, p. 120).

The contribution to professional practice of bibliometrics-based assessments in the context of evaluation tasks can be recognised in their full scale introduction and their rapidly increasing use. However, empirically-based evidence of the steering effects of bibliometric based rankings is only available for a few cases (Weingart, 2005, p. 117). Doubts about the trustworthiness of bibliometric indicators also emerge from the following quote: "Bibliometric indicators have become such a powerful tool in the context of science policy making and budgetary decisions that their potential misleading and even destructive use must be acknowledged" (Weingart, 2005, p. 130).

In 1995, the University of Strathclyde examined the correlation of the judgment made by the panel system of the 1992 RAE and the outcome of citation counting. To this end, a citation count was performed using the ISI Social Science Citation Index database and incorporating RAE assessed departments of library and information science. It was found that the bibliometric method of citation counting using an abstract and citation database was associated with a number of limitations. For example, not all staff of the assessed departments were cited - between 11% and 90% of the staff of the library and information science departments participating in the 1992 RAE - were not cited. However, on balance, it was found that these limitations could be overcome by looking at the rankings of the departments rather than the absolute figures (Oppenheim, 1995, pp. 20-21). In conclusion the results of the study acknowledged that there was a strong correlation between the RAE rankings based on peer reviews and the rankings based on citation counting. These findings suggested that considerable public money could be saved using citation counting to produce virtually identical rankings. The results also indicated that "similar results would be obtained in other subject areas". This likelihood was later confirmed by a study from the same author, establishing a strong correlation between citation counts and RAE ratings, using essentially the same methodology, but encompassing a larger area of scientific research: Anatomy, Archaeology and

Genetics (Oppenheim, 1997). When discussing the implications of the outcomes of these studies, Oppenheim cautioned that citation counts should not be used as the only tool to assess the performance of research units but should be utilised to propose the *rank ordering*, while the assignment of the RAE *scores* should remain the task for the panel of experts.

The findings of the Oppenheim studies were based on rankings created by using the Spearman Rank Order Correlation coefficient which is regarded as "…an appropriate correlation … for ranked data" (Howell, 2010, p. 304). The contribution to professional practice of the two Oppenheim studies is that was demonstrated that bibliometrics-based assessments in the context of evaluation tasks offer the Funding Councils the opportunity for a cheaper and faster RAE. Additionally, through this method universities were given the opportunity to predict how they would perform in the RAE, thus facilitating remedial action or improved financial planning (Oppenheim, 1997, pp. 482, 484 and 485).

In the assessment in higher education literature there is unanimous agreement concerning the imperfections of using outcome measures, these being far from reliable. One of the issues emerging with the use of publications as output measures is that of authorship. Here, it is acknowledged that adding economic considerations to the existing rewards of power and prestige of authorship may have an impact on authorship issues, the latter ranging from g*ift authorship*[14] to *ghost authorship*[15]. Critics highlight how the RAE approach is missing a mechanism for the accurate assessment of individual contributions (Sheikh, 2000, pp. 423 and 425). This notion of publication misconduct is mainly based on anecdotal accounts from many editors of biomedical journals. Despite of little empirical evidence (Sheikh, 2000, p. 422) it seems this notion trustworthy. The example of the authorship issues demonstrates that assessing performance through measuring research outputs is simplistic and fails to make judgements about performance in a meaningful way.

The key point emerging from the review of the literature on measures/indicators used in higher education so far is that in contrast to the globally accepted

[14] Gift authorship occurs when someone who has made an insignificant contribution to a paper is listed as a co-author

[15] Ghost authorship occurs when someone who has made a substantial contribution is not cited as a co-author.

research methods employed at universities worldwide in a wide spectrum of domains, universally accepted research methods to scientifically assess research performance, perhaps with the exception of the RAE approach, appear to be missing. Hence, the need to identify a set of appropriate *indicators* for the key criteria of research performance and to develop a system which makes it possible to standardise performance indicators, at least at European level (Korhonen, Taino and Wallenius, 2001, pp. 121-122).

Contributions to the discourse about the use *indicators* as *measure* of performance and guide for resource allocation originate also from the United States. In 1998 an eight point critique concerning the use of performance measurement *indicators* by Perrin became pivotal in this discourse. Perrin's critique encompassed the following elements:

> *(1) varying interpretations of the "same" terms and concepts; (2) goal displacement; (3) [the] use of meaningless and irrelevant measures; (4) [the] confounding of cost savings versus cost shifting; (5) ... misleading aggregate indicators; (6) [the] limitations of objective-based approaches ...; (7) [the] uselessness of performance indicators for decision making and resource allocation; (8) inconsistency between a narrow focus on measurement and larger new public management precepts' .*

Feller, 2002, p. 436.

These points of critique highlighted that the value of research performance *indicators* is limited compared with proper *measurements*. This was further reflected in 2001 in the strong belief of the National Academy of Sciences that "…through the use of quantitative measures … research programs, especially those supporting basic research, cannot be meaningfully evaluated (Feller, 2002, p. 451). In the context of the aforementioned caveats of research performance *indicators*, it was recommended that care should be taken when accepting claims made by evaluators indicating that achievements in performance had been accurately recorded and that these improvements were causally related to changes associated with the appropriate use of appropriate measures. To overcome these limitations, it was advocated that a return to expert panels to evaluate academic performance should be reconsidered (Feller, 2002, p. 450).

Not only are disadvantages of bibliometrics as indicators of research performance found in the literature, also their advantages have emerged from the literature. Bibliometrics eliminate personal bias because they are based on publications and citations resulting from the decisions of authors, editors and reviewers. The judgements of such people are not motivated by the need to be counted for evaluation. Moreover, bibliometrics are usually determined by a much larger number of publications and citations than peer review evaluations. Here, the strengths of bibliometrics are that they can reveal macro-patterns; for instance, they can reveal unexpected areas of research leadership or the connections between disciplines (Weingart, 2005, pp. 122-124).

The vast majority of the literature takes issue with the assumption that metrics are a proxy[16] for the overall research quality. For example, the imperfections emerging from the literature about the best known bibliometric indicator the *Journal Impact Factor* and its data source Web of Science include: (1) country and language bias; (2) bias because of different citation behaviour in the various disciplines; (3) bias because of the different coverage of certain subjects; (4) bias because of the need for bibliographical cleansing; (5) bias because of self-citation patterns. Furthermore, even in 2011, the Web of Science data source only covered about 12,000 (52%) of the approximate 23,000 peer reviewed journals listed in *Ulrich's Periodical Index*. Moreover, many geographical areas of the world are underrepresented in Web of Science because of a pre-eminence of North American and European English language journals. Bias because of the varying coverage of certain subjects is demonstrated, for example, with palaeontology. In this research area, it was found that 85% of all palaeontology journals were not indexed, thereby resulting in the omission of a *Journal Impact Factor* (Steele, Butler and Kingsley, 2006, p. 280). Non-excellent coverage is further found in those disciplines where books and conference proceedings are the main outlets of publications; for example,

[16] Proxy: "a figure used to represent the value of something in a calculation" (Stevenson and Waite, 2011, 1156).

only 10% of the publications by British researchers in law were covered by *Web of Science* (Steele, Butler and Kingsley, 2006, p. 281).

The limitations and bias of bibliometric performance indicators and their data sources, particularly in the social sciences and humanities, have initiated a quest for alternative performance indicators encompassing: (1) the number of times a paper is read; (2) download usage statistics; (3) evaluative indicators for publications in the social sciences, particularly in the arts & humanities; (4) key journal listings in a number of disciplines; (5) venue and audience attendance in the performing and visual arts.

Furthermore, the imperfections of peer-review-only evaluations (time and costs) as well as those of bibliometric-indicator-only evaluations (bias) have led to recommendations of *new composite measurements* that should rely on a variety of sources, including Abstract and Citation databases like Scopus and Web of Science but also including Google Scholar, Microsoft's Windows Live Academic Research and usage statistics (Steele, Butler and Kingsley, 2006, pp. 280-282, and 286).

Research assessment exercises have proved to be the catalyst of the introduction of such *new composite measurements*, for example, quantitative bibliometric performance indicators were introduced alongside peer review in the 2008 Australian Research Quality Framework (RQF) (Steele, Butler and Kingsley, 2006, p. 288). This RQF broadly followed the same procedure as the RAE: assessments were undertaken by discipline-based panels which were to rank the quality and impact of research groups on a scale from 1 (below the quality standard) to 5 (world-leading research). The addition of bibliometric measurements to peer review outcomes was based on the assumption that neither a small panel of peers, a single measure nor a 'basket' of indicators could provide an error-free judgement and that therefore the most sensible approach was to use a combination of two methods (Butler, 2008, pp. 90-91).

Among the measurements taken into consideration including grant income and ranked outputs, bibliometric measurements were favourite. Measurements that were considered but rejected included: (1) web measurements which were rejected because of concerns about how they could be audited and manipulated; (2) collaboration measurements, these being rejected because of the time-consuming process to collect the data; (3*) Journal Impact Factors*, which were rejected since the actual citation counts offered a better measure for the groups' performances. Key in the use of measurements was that each discipline panel used its own set of preferred metrics. Here, it was recognised that for the social sciences and humanities in particular, an alternative extraction of citation count methods had to be applied since the *Web of Knowledge* covered less than half their output (Butler, 2008, pp. 89-90).

The relevance of the evaluation of the Australian RQF relevant for the present research is that it elaborates on the advantages of *composite measurements* by providing the reasons for a balanced approach to research performance. The recommendation for *composite measures* - "The most sensible approach is to combine the 2 methods" (Butler, 2008, p. 91) - draws on the limitations of *single measures* and *multiple measures* as discussed earlier in this chapter. The better trustworthiness when using *composite measures* is explained by reference to "many studies [demonstrating that], the 2 methods will usually produce similar results" (Butler, 2008, p. 91) and to the characteristics of *triangulation* allowing cross-checking of findings in one approach.

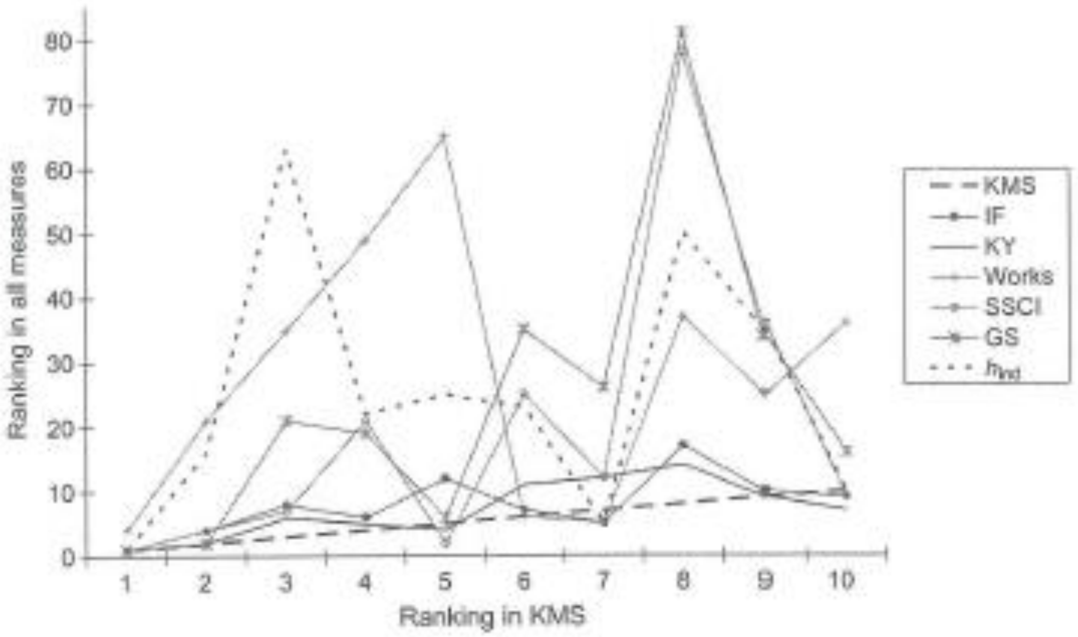
Almost three decades after the first research assessment was held in the UK and followed by continuous attempts to solve the enduring issue of what measurements to employ, no consensus has been reached about the measurements to use and how assessments should be conducted (Henrekson and Waldström, 2011, p. 1139). To identify the most universally applicable measure out of seven of the most established and commonly used measurements of research performance, an analysis was made to identify the extent to which outcomes of assessments were dependent on the bibliometric measurements used. Included in the analysis were four measurements based on weighted publications: (1) KMS; (2) the Impact Factor; (3) Kodrzycki and Yu; (4) 'Works', and three measurements based on citations: (1) *Social Science Citation Index*; (2) *Google Scholar*; (3) the *h-index*. Here, the measurements were used to rank Swedish professors in economics.

KMS, named after one of its developers Kalaitzidakis, is one of the most widely cited rankings of economic journals during recent years and is described as "being the most up-to-date set of objective journals weights available"

(Henrekson and Waldenstrőm, 2011, p. 1143). It encompasses 159 journals in the ‘economy’ category in Thomson-Reuters’ Journal Citation Reports (JCR). The *Journal Impact Factor* developed by Eugene Garfield the founder of ISI is now being calculated by Thomson Reuters and reported in their JCR. This metric is defined as “...one year’s average number of citations to a journal’s articles that were published during the two preceding years” (Henrekson and Waldenstrőm, 2011, p. 1144). The Kodrzycki and Yu measure is based on all journals in the Social Science Citation Index and encompasses data from the period 1996 to 2003 (Henrekson and Waldenstrőm, 2011, p. 1144). “Works” refers to a weighted publication measure, including all kinds of formats of published research output, such as journal articles, book chapters and monographs, these being included in *EconLit* (Henrekson and Waldenstrőm, 2011, p. 1145). Of the measures based on citations, the *Social Science Citation Index* refers to a measure constructed by using the Social Science Citation Index as data source for the calculation of the total number of citations of the five most cited works of each author (Henrekson and Waldenstrőm, 2011, p. 1146). Here, the five most cited works are considered to create a balance between counting all the citations of all the works of an author, which may lead to biased results in the lower end, and counting only the single most cited work, which would give no credit to authors with a number of well-cited works (Henrekson and Waldenstrőm, 2011, p. 1146). *Google Scholar* refers to a measure composed of actual citations derived from Google Scholar, encompassing any of the internet recorded publications of an author (Henrekson and Waldenstrőm, 2011, p. 1147). The *h-index* was developed in 2005 by Hirsch and defines a researcher with an *h-index* of *x* as having published *x* papers which have been at least *x* times cited (Henrekson and Waldenstrőm, 2011, p. 1147). As this metric emphasises sustained productivity, it is referred to by some critics as ‘age’-index.

The results from using the seven measures to rank Swedish Top-10 professors in the economy show large discrepancies between the measures, as shown in Figure 28.

Figure 28: Rankings of Swedish Top-10 professors in economy using 7 established measures.



Henrekson and Waldenstrőm, 2011, p. 1149.

Relevant for the present research is that the *Journal Impact Factor* emerged from the comparative analysis of the seven most established and commonly used measurements of research performance, as the most useful bibliometric measurement, based on the assumption that “the most useful measure is the one that is the most correlated with all the other measures” (Henrekson and Waldenstrőm, 2011, p. 1153). Here, the degree of overlap between the rankings was based on Spearman and Pearson correlations - use of these common used statistical tools make the outcomes of the quantitative analysis trustworthy. However, the trustworthiness of the empirical evidence, admittedly obtained via regular statistical methods, should be re-considered. One reason for this is of a more conceptual nature: journal-based measurements are criticised since “they give the same merit to all articles in a journal regardless of their actual impact (Henrekson and Waldenstrőm (2011, p. 1144).

A new measurement - *Research competency* - available in Elsevier’s SciVal[17] has been used in an exploration of research excellence in the UK, the USA,

[17] SciVal offers quick, easy access to the research performance of 4,600 research institutions and 220 countries worldwide. - See more at: http://www.elsevier.com/online-tools/research-intelligence/products-and-services/scival#sthash.

Japan, Australia and Germany. The aim of that study was to elucidate how funding systems affect research excellence (Wellings and Winzer, 2011). This new measure assesses research excellence through co-citation analysis[18] based on the number of publications, the number of citations and a measurement of novelty. What was analysed is the *competency* data for the period 2006-2010. The researchers found that there was no single route to research excellence, but that a combination of factors and the interaction between these factors together with the context of a country's science system affect research performance. A connection was found between the national expenditure on research, as expressed by GERD[19] and the number of areas of research excellence, as shown in Table 7. The differences shown in the column *Competencies per $ Bn* are an indication that other factors are also at play.

Table 7: Dimensions of research efficiency

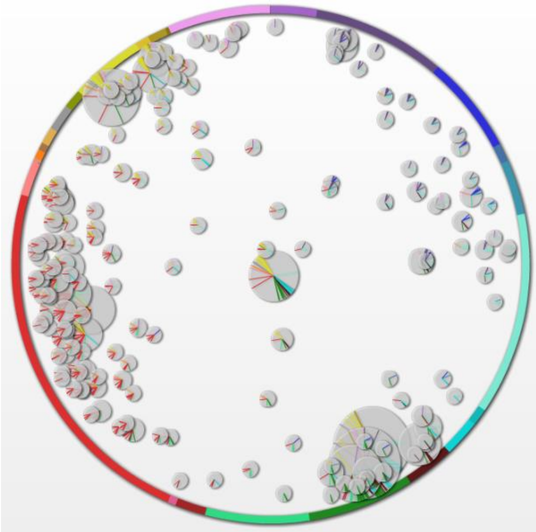
Country	No. of competencies (2006-2010)	GERD in $ Bn	Competencies per $ Bn (GERD)*	Competencies per thousand researchers	Level of GERD financed by Government	HERD as % of GDP 2008
UK	418	40.10	10.42	1.66	30.7	0.47
USA	1817	398.19	4.56	1.29	27.1	0.36
Australia	130	18.76	6.93	1.42	34.9	0.54
Japan	398	148.72	2.68	0.61	15.6	0.43
China	885	120.61	7.34	0.56	23.6	0.13
Germany	396	81.85	4.84	1.31	28.4	0.45

Wellings and Winzer, 2011, pp. 8-10.

It was further found that national funding priorities affect the presence of research excellence in different disciplines. For example, Australia's tightly targeted funding policy is mirrored in the presence of excellence in few disciplines, as depicted in Figure 29.

[18] Co-citation analysis: "a co-citation is taken to exist if two references or authors appear in the same bibliography. It is interpreted as a measure for similarity of content of the two references or authors" (Gmǚr, 2003, p. 27).
[19] GERD: gross domestic expenditure on research and development

Figure 29: Research competencies in Australia.



SciVal (no date).

Figure 29 shows concentrations of research excellence in the disciplines of social sciences (top left), medicine (middle left) and agricultural and biological sciences (bottom right). Another finding was that the *health* of the science system is the basis of sustained research excellence. Low competency growth combined with a low increase in R&D spending may be a warning signal. In conclusion, it was further found that when funding is concentrated on areas according to merit, research intensive institutions make the largest contributions to national excellence (Wellings and Winzer 2011, pp. 1-3). The relevance of employing the new quantitative bibliometric measurement *research competency* in the comparative study of five countries is in the provision of empirical evidence that among the key factors affecting research performance are national expenditure on research, national funding priorities and the health of the national science system, whereas funding seems most effective when assigned to high achieving institutions. Within the caveats connected to the available bibliographic sources on which the co-citation analyses are drawing, it can be concluded that this recognised bibliometric method using *research competencies* produces trustworthy outcomes.

The *Snowball initiative* of 2012 is an example of an attempt by research intensive universities around the globe to come to an agreement about methodologies which are robust and clearly defined to achieve measurements that enable the confident comparison of research strength. The metrics developed here are data source- and system-agnostic. To date, 24 Snowball metrics have been defined, these comprising: 7 research indicators, including *citation count* and the *h-index*; 4 indicators of collaboration, including the *Collaboration impact*; 2 indicators of societal impact, including Altmetrics; 4 entrepreneurial/economic indicators, including *Intellectual Property Income* and *Sustainable spin-offs* (Snowball metrics, no date). The contribution to professional practice is that the Snowball metrics when becoming global standards allow institutional benchmarking and cover the entire spectrum of research activities

One of the more recent additions to the performance indicators in higher education literature is reporting about seven key performance indicators emerging from a competition for governmental funding held in the Spring of 2013 in which 54 Russian universities participated and twelve universities received governmental support (Luneva, 2015, pp. 194- 200). Aim of the competition – called the “5-100” program - was to ensure the upgrade of five Russian universities into the Top-100 of one of the three world university rankings: Times Higher Education (THE), Quacquarelli Symonds Limited (QS) and Academic Ranking of World Universities - Shanghai Jiao Tong University (ARWU). The seven indicators emerging as *key* were: (1) position in the QS Ranking; (2) publications per faculty member; (3) citations per faculty member; (4) per cent foreign faculty; (5) per cent foreign students; (6) average Unified State Examination (USE) score; (7) per cent external revenue. An analysis of the seven key performance indicators for the twelve *winning* universities showed that the numerical values of some indicators varied significantly over the twelve universities. For example the highest value of the indicator *publications per faculty member* (12.0) varied 60 times from the lowest value (0.2) of this indicator (Luneva, 2015, p. 196). It was further concluded that: (1) the *number of publications* and the *number of citations* are the two most important indicators for the performance evaluation of Russian universities and their individual employees; (2) the indicator *university image among employers* - having a 10% share in the calculation of the QS ranking - is absent amongst the Russian key indicators; (3) Russian universities pay little attention to the indicator *image in academic community* – which could help universities improving their research potential; (4) only two out of the twelve *winning* universities scored ≥ 25% on the indicator *per cent foreign students* –whereas all universities in the QS Top-100 ranking scored ≥ 25% on this indicator (Luneva, 2015, p. 198).

The relevance for the present research of the measurements used in Russian higher education is that it demonstrates the enduring nature of the search for a universally applicable set of key research performance measurements/indicators. The results highlighted are congruent with many other such studies identifying *publication counts* and *citation counts* as the two key performance indicators. The results further show that indicators for intangible topics such as *university image among employers* are absent among the key indicators, whereas low scores are found for the indicator *image in academic community.* These outcomes suggest that further research into a methodology to capture intangible determinants of research performance into indicators is required.

To sum up this section of the chapter, it can be concluded that since the first research performance measurement in higher education in the early-1980s, it has been found that no single measure is capable of assessing research performance. Here, the following accountability *hype* has brought bibliometrics from the niches of academia to a strategic position in policy making, this being based on the correlations found between panel judgements and citation counting. However, care must be taken because bibliometrics may be misleading or even destructive, therefore *composite measures*, encompassing a *balanced* set of measures should be used.

Comparing and contrasting the findings in this sub-section of the chapter with the findings in sub-sections 2.3.9 and 2.3.10 (measures in the corporate sector literature) reveals that developments in both sectors are congruent; here no single measure is appropriate to measure performance and a *balanced* combination of measurements is required. The difference between the dominance of financial measures in the corporate literature and bibliometric measures in the higher education literature is the difference in the uniformity of the measures, which is present for financial measures and lacking for (most) bibliometric measures, the latter in part caused by the lack of *robustness* of the underlying data sources. Thus, the selection of the right measures emerges as a critical step in performance measurement in both the corporate and the higher education sectors by which poorly chosen measures provide meaningless data or encourage the wrong behaviour.

2.4.7 Appreciation of Porter’s Models and Alternative Approaches in Relation to the Objectives of the Research

As regards the attempt in the previous sub-sections of this chapter to provide an appreciation of Porter’s models and the most salient alternative performance measurement approaches employed in higher education should be acknowledged that the notion emerges from the literature that by the time of writing of this thesis “… no systematic comparison of different performance management and incentive systems exists. In addition, alternative concepts and recommendations for performance management and incentive systems tailored for research settings are scarce” (Ringelhan et al., 2015, p. 88). Here, the key point that emerges from the review of the literature is that in contrast to the globally accepted research methods employed at universities worldwide in a wide spectrum of domains, universally accepted research methods to scientifically assess research performance appear to be missing (perhaps with the exception of the RAE approach).

Within this context, a more conceptual than comprehensive overview of performance measurement systems used in higher education is presented. In the overview, the performance measurement systems are categorised into three groups: output, process and input control systems.

Output control systems influence behaviour in two ways: (1) indirectly, for example, through rankings, (quasi) competition and greater transparency in the reputation of scholars and organisations ; (2) directly, via performance-based funding, performance-based payment and target agreements. Here, the employment of direct output control systems involves more autonomy for the institutions together with greater external governance by the stakeholders. This is generally performed via evaluations of tenured research staff and research outputs. Among the frequently used measurable performance indicators in output control systems are: (1) the amount of third-party funding; (2) the number of doctoral students; (3) the number of publications and citations. Here, the choice of indicators is highly debatable (Ringelhan et al., 2015, p. 89).

A widespread alternative for output control systems is the (informed) peer review, a qualitative evaluation informed by (quantitative and) qualitative indicators. In addition, the post-publication review also emerges as an alternative in addition to the qualitative evaluation method (Ringelhan et al., , 2015, p. 90).

Process control systems offer an alternative when the measurability of outputs is low. One weakness of process control systems is however that these require a precise knowledge of cause-and-effect relationships. An example of a process control system is the peer control in the accreditation of research organisations. For example, via the evaluation of the number of foreign professors and the provision of regulations that should be obeyed (Ringelhan et al.,, 2015, p. 90).

Input control systems offer an alternative when the measurability of outputs is low and a precise knowledge of cause-and-effect relationships is absent. Since input control systems are applicable when tasks are complex and ambiguous, such systems are suitable in higher education. Examples of the employment of input control systems can be found, for example in the US where universities such as Harvard rely on a thorough selection of ‘the best’ scientists. This is also the case in Germany, where research organisations evaluate applicants against a selection criteria which includes: (1) an ability for critical thinking; (2) an urge for exploration and experimentation; (3) professional standards (Ringelhan et al., 2015, pp. 90-91).

A tabular presentation of a conceptual overview of performance measurement systems used in higher education is presented in the following table.

Table 8: Conceptual overview of performance measurement systems used in higher education

Management control method	Governance mechanism	Performance management tool	Evaluation method
Output control	Indirect	• Constitution of (quasi) competition	• Performance indicator
		• More transparency (e.g., through rankings)	
	Direct	• Distribution of funds	
		• Performance-based payment	
		• Target agreements	
		• Autonomy and budget responsibility	
		• Central evaluation (e.g., of teaching)	
Input control	Indirect	• Selection of qualified scientists	• Qualitative evaluation and selection criteria for applicants, such as profes-sional standards (e.g., crit-ical thinking, as well as an urge for exploration and experimentation)
		• Trust in the intrinsic motiva-tion of employees	
		• Independence as, for example, guaranteed by article 5 of the Basic Law of the Federal Republic of Germany	
Process control	Direct	• Accreditation of research organizations	• Peer control, for example, in the accredita-tion process (evaluation of performance, for example, by the number of foreign professors)
		• Regulations that are obeyed	

Ringelhan et al., 2015, p. 91.

Already in the early 1980s demonstrated the outcomes of one of the first empirical studies of research performance how consistent results were obtained using four indicators: (1) the number of highly cited papers; (2) peer evaluation; (3) the number of publications per researcher; (4) the number of citations per paper. These measurements have played a key role in most performance measurements ever since. Despite the fact that in many studies a strong correlation between the outcomes of a peer review and citation counting can be found, it is necessary to be cautious since citation counts should not be used as the only tool to assess research performance. This is because they are far from reliable owing to the limitations of their sources. Here, reliable output measurements should facilitate a confident comparison of research strength, drawing on metrics that are data source- and system-agnostic. Despite their caveats, the use of (bibliometric) output measures is also advantageous because these eliminate the personal bias which may be connected to peer review evaluations.

The limitations of traditional bibliometric measurements have initiated the use of alternative quantitative performance indicators encompassing: (1) the number of times a paper is read; (2) download usage statistics; (3) evaluative indicators for publications in the social sciences (particularly in the arts & humanities); (4) key journal listings in a number of disciplines; (5) venue and audience attendance in the performing and visual arts. Furthermore, the imperfections of peer-review-only evaluations (time and costs) as well as those of bibliometric-indicator-only evaluations (bias) have resulted in the development of *new composite measurements* - combining in a 'balanced' way the measurements derived with help of quantitative and qualitative methods. The improved trustworthiness of these *composite measures* draws on many studies demonstrating that quantitative and qualitative methods usually produce similar results and thus allow *triangulation* – the cross-checking of findings in one approach. Here, the combination of various measures in Porter's diamond can be viewed as a *composite measure.*

One of the latest developments in alternative quantitative performance indicators is *Research competency* - the assessment of research excellence through co-citation analysis based on the number of publications, the number of citations and a measurement of novelty. This novel measurement allows for example to reveal the connection between research performance and the national environment by illuminating the connection between GERD[20] and research excellence or to disclose the *health* of the science system via a

[20] GERD: gross domestic expenditure on research and development

measurement capturing the two concepts of competency growth and of increase in R&D spending.

As mentioned earlier in this sub-section of the chapter, the choice of measures is difficult and often debatable. However, the outcomes of a study in UK higher education demonstrated that the condition of the competitiveness created by research can be established with the help of Porter's diamond model, taking only a few measurements into consideration. These outcomes also show that when selecting a 'balanced' set of measures, each corner of the diamond contributes almost equally to the competitive condition, explaining about 2/3 of the shared variance between the measurements and performance.

The review of the literature shows that a wide variety of (sometimes only slightly different) measures emerges from the performance measurement in higher education literature. Within this context, is it inevitable that not everything has been captured in this chapter. Therefore, a more conceptual overview rather than a comprehensive overview of performance measurements/indicators used in higher education is presented in this section. In the overview, the performance measurement systems are categorised according to three criteria: the nature of the measurement, the measurement method and the data type.

Table 9: Overview of the performance measurements applied in research organisations

Nature of measurement	Measurement method	Data type	Performance indicator
Quantitative	Counting/calculation	Institutional/ departmental	Ratio teaching to research funding
			Total income
			Percent research income
			Ratio external\income to research staff
			Ratio research students to research staff
			Ratio research studentships funded Research Councils to all studentships
			Staff weighted grade all departments
			Percent research staff
			Percent research in RAE grade =>4 departments
			Percent research in RAE grade =>4 in geography departments
			Number of academic staff
			Ratio research support staff to research academic staff
			Doctoral degrees awarded
			Intellectual property income
			Sustainable spin-off income
		Bibliometric	Publication counts
			Publications per researcher
			Citation counts
			Citations per paper
			Journal impact factor
			Reading statistics
			FTA-download statistics
			h-Index
		Societal-metric	Altmetrics
	Ranking	Bibliometric	Key journal listings
		Bibliometric/non-bibliometric	Key university rankings
	Co-citation analysis	Bibliometric	Research competencies
Qualitative	Peer review		Expert (panel) assessments

Although the review of the extant literature on performance measurement systems in the higher education sector clearly does not provide a one-size-fits-all solution for the research problem of this study is the aim of the following table to make the matches between the approaches reviewed and the objectives of this study more transparent.

Table 10: Matches between the approaches reviewed and the objectives of this study

Key objective of this study	**Porter's method (Mixed methods)**	**(Qualitative) Peer review (RAE) approach**	**(Quantitative) Bibliometric methods**
Introduce 'best practices' from different domains in the higher education domain.	Although use of Porter's model in the corporate sector is well established, this is more an exception than a rule In higher education.	The ubiquitous presence of the British *Research Assessment Exercise* (RAE) model - now the *Research Excellence Framework* (REF) model - has emerged from the literature on performance measurement systems as used in higher education	Since the early 1990s, academic institutions in several countries have been established to provide the data, to develop indicators and to perform the quantitative analyses of every nation's science system.
Improve the understanding of how university performance in research is created and developed to be more effective, so reaching the universities' strategic goals.	Porter's diamond and *four stages of competitive development* models locate research departments/ institutes along a spectrum of development according to their competitive advantage and vis-a-vis their peer group; these draw on the quantitative and qualitative outcomes of an assessment of their research		

Identify key measurements of university performance and explain their impact.	The selection of variables to represent each of the four corners of the diamond is difficult because: (1) no strong causal relationship between a *single* variable and any of the four corners can be established - suggesting the application of *many* variables; (2) strong intercorrelation exists between related variables - suggesting the use of *few* variables.	Assessment of the works submitted to the exercise was carried out using peer review. The RAE in the UK encompassed the peer review of about 50% (200,000 outputs) of the total research output of the evaluated institutions at a cost of about €20 m per exercise (=about €100 per unit output),	Fairly consistent results were obtained with the following four indicators: (1) the number of highly cited papers; (2) the number of publications per researcher; (3) the number of citations per paper. However, doubts about the trustworthiness of bibliometric indicators have emerged from the literature drawing on the number of limitations associated with the data sources used.
Provide (a) theoretical framework(s) of university performance.	The outcome of the quantitative assessment of competitiveness provides four scatterplots depicting the competitiveness of each assessed department/institute vis-à-vis its competitors. Here, the relative condition in each of the scatterplots corresponds to the condition of each of the corners of the diamond so that the condition of the diamond corresponds to the stage of competitive development.	A conceptual framework of the RAE/REF (peer review) approach comprises three broad levels: (1) the structures and processes *outside* the universities; (2) the preparatory activities and coordination *within* the universities; (3) the resulting judgements and their consequences; and seven key elements including the evaluation unit, peer committee, etc.	

Provide a contribution to professional practice with a practical solution for the research problem	Curran's confirmation that Porter's thesis helps to model the competitive environment that universities face and the recognition that Porter's models are conceptualised around departmental, institutional and national levels makes Porter's model suitable for use in this study; this uses the university as a Unit of Analysis.	Evidence from various research fields confirmed that the rankings awarded by its panel system are reasonable and realistic. However, there is criticism that the use of panels makes the exercises very costly.	An large amount of empirical evidence shows that the method of using bibliometric indicators is useful to science policy-makers, helping them to formulate an explicit science policy. In addition, universities are given the opportunity to predict how they would perform in the research assessments, thus facilitating remedial action or improved financial planning. The imperfections of bibliometric-indicator-only evaluations (bias) have led to recommendations for *new composite measurements* comprising quantitative and qualitative measurements.

The tabular presentation of the match between the most salient approaches reviewed and the objectives of this study highlights how peer review and bibliometric approaches fail to provide an understanding of how university performance in research is created and developed – this being one of the two main aims of this study. Peer review and bibliometry seem in essence to be output measurement methods and do not provide a framework from which to abstract the development of university competitiveness, nor do they explain the impact of its key determinants.

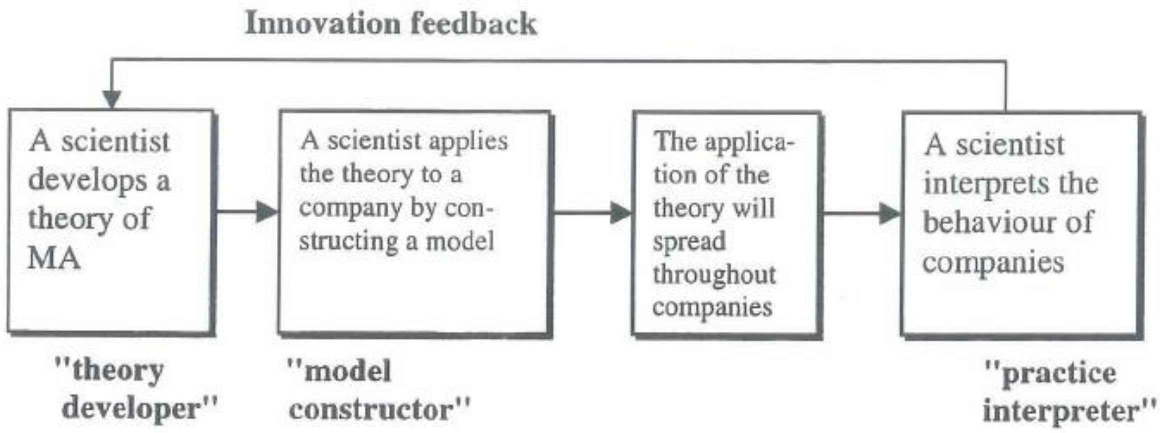
In spite of the range of criticisms of Porter's thesis, the latter remain relevant and central to this thesis. Despite that researchers as Magaziner (1990) and Davies and Ellis (2000) at length critique Porter's thesis, from the perspective of the author there has been nothing that surpasses it in terms "to help firms and governments choose better strategies" (Clark, 1991, p. 118) and to provide "a cogent explanation of competitive advantage" Grant (1991, p. 547) and therefore, while being aware of the limitations of Porter's models as expressed in this chapter, it is nevertheless appropriate to apply them in this study.

A tabular summary of the precedent studies concerning performance measurement in the higher education sector is given in Appendix 2. The following section of the chapter presents a conceptual model of performance measurements in the higher education sector, drawing on the literature reviewed.

2.5 Development of a Conceptual Model of Research Measurement

The most common research approach emerging from the review of the precedent literature in this chapter is the *theory based* approach, this being discipline-based, university-centred and performed by highly trained individuals. The quality of the research is safeguarded by a peer review of research proposals and resulting journal articles. The *theory based* approach starts with the development of a *theory*, this being applied in organisations with the construction of a *model*. Once successfully spread throughout the organisation, this affects the behaviour of the organisation and its workers. This approach is recommended because "... it has a strong theoretical foundation that leads to a tolerable degree of failure in applications" (Laitinen, 2003, p. 297). The use of the *theory based* approach in management accounting research is depicted in Figure 30.

Figure 30: The theory based approach as used in management accounting research.

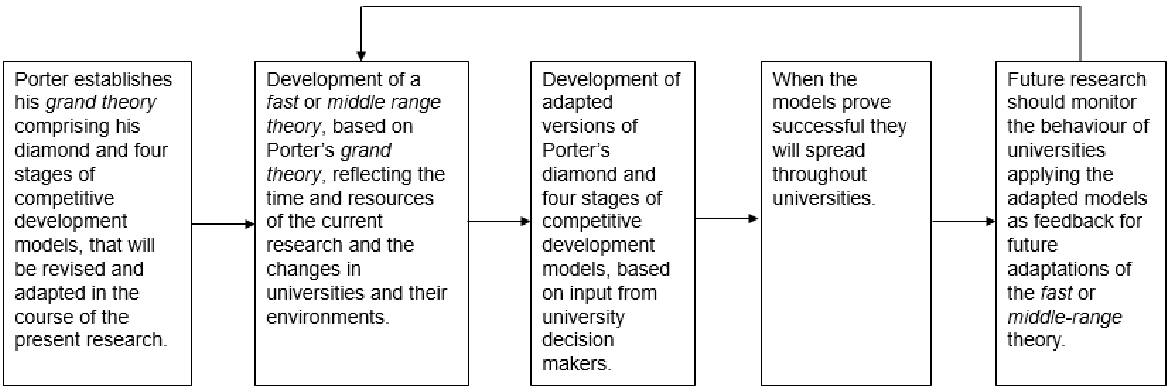


Laitinen, 2003, p. 296.

A disadvantage of this approach is that academic researchers may produce knowledge for knowledge's sake, to be used only by other academics, and hence the link to theory development and practical application may be weak. Another important disadvantage of this approach is the likelihood of quick changes in the field rendering developed theories already out of date when finished.

To avoid the aforementioned production of knowledge for knowledge sake in the present research an adaptation of the *Future-based MA research approach* as developed by Laitinen (2003, pp. 299-300) will be used. Point of departure by the adapted approach in the present research are established *grand-theories* comprising *Measurement Theory* and Porter's theories in his *The Competitive Advantage of Nations*, that will be revised and adapted in the course of the research to fit the environment and scope of the present study. Based on the established *grand-theories* and reflecting the available resources of the current research as well as the continuous changes in the topic of investigation in the present research - universities and their environments - an adapted version of the established theory will be developed, the so-called *fast theory* or *middle range theory,* which will be used to further develop a model drawing on the established *grand-theory*, collected data and input from decision makers in universities. That theory is identified as *fast* because it will be developed in the course of the present research, the theory is also identified as *middle range* because it integrates theory and empirical research (Merton, 1949, pp. 39-53). The aim of the model is that once it is shown to be successful, it will be spread throughout universities and thereby contribute to professional practice in the field. It is assumed that future research should monitor the behaviour of universities applying the model as feedback for further adaptations of the *fast* or *middle range theory* and model.

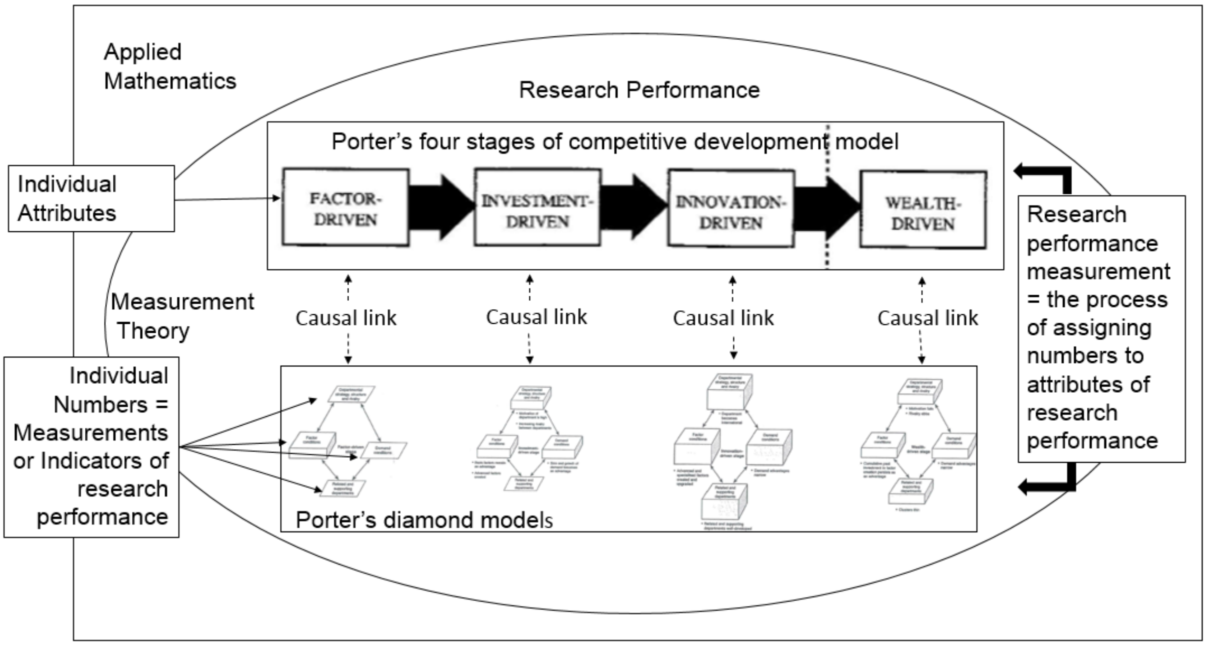
Figure 31: Conceptual model of the approach in the present study



Based on Laitinen, 2003, p. 300.

The first step in the further development of the present research is the integration of *Measurement Theory* and Porter's diamond and four stages of competitive development models into a conceptual model of measuring research performance in higher education that will be will be further developed in the course of the present research. The synthesis of *Measurement Theory* and Porter's diamond and four stages of competitive development models is depicted in Figure 32.

Figure 32: Conceptual model of measuring research performance in higher education



Adapted from Morrison, 2003, p. 6.

As depicted in Figure 32 is the relevant theoretical foundation of performance measurement drawing on *measurement theory*, belonging to the domain of applied mathematics. The object to be measured, here the construct *research performance,* is depicted by Porter's four stages of competitive development model, drawing on the assumption that the true condition of *research performance* corresponds with one of the four stages in Porter's model. A fundamental issue in performance measurement is that not the *object,* here *research performance*, is being measured but instead a representation of it. Depending of the rigorousness of the approach are these representations termed *measurements* (=rigorous) or *indicators* (=less rigorous). A consequence of the measurement of *research performance* through *measurements* or *indicators* is that conclusions drawn about *research performance* are impacted by the correspondence between the *attributes of research performance* considered and the measurements of these attributes by means of indicators. Therefore must there be *causal links* between the measures and the phenomena to be measured. The individual measurements or indicators corresponding with the individual attributes of research performance are captured in Porter's diamond model. Porter's diamond model is thus a *composite measure* representing a balanced emphasis on all attributes of research performance.

The rationale for the application of the methodology used in the present research to identify, select and analyse the information applied to answer the research question and to allow the reader to critically evaluate the present research's overall validity and reliability is presented in the next chapter of the thesis.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

In the review of the performance measurement in the higher education literature of the previous chapter, the quantitative bibliometric approach to supplement the ubiquitous qualitative (RAE/REF-type) approach emerged. Here, the enhancement of research performance measurement via the peer review approach, with the addition of a bibliometric approach, drew on the assumption that neither approach could provide an error-free judgement. Because of this, the most sensible approach is to use a combination of the two methods (see Section 2.4.6). Porter also combined a qualitative and quantitative approach when he used "… available statistical data, supplementary published sources, and field interviews" (Porter, 1998, p. 24) to build his thesis for the *Competitive advantage of nations*. This use of qualitative and quantitative approaches in a single study indicates the direction for the present research and links the literature reviewed to the methodology developed in this chapter.

The aim of this chapter is to describe the rationale for the methodology developed to identify, collect and analyse the information applied in order to answer the research question, so allowing the reader to critically evaluate the present research overall validity and reliability. This aim is congruent with

Blaikie's (2010, p. 15) definition of *research design* as presented in the following quote: "A research design is an integrated statement of and justification for the technical decisions involved in planning a research project". The focus in this chapter is therefore on the technical decisions made on how the data is obtained and which methods are used to analyse the data.

The following research design aims to incorporate all the considerations and decisions that have to be made and to provide a justification for the decisions made. The chapter includes an elaboration on the ontological and epistemological assumptions on which the chosen research methods are founded, and is followed by an outline of the research paradigms within which the present research is conducted and the impact of these orientations and stances on the research methodology and subsequent data collection and analysis methods. The chapter further describes the nature of knowledge and the approaches of accessing that knowledge within the context of a mixed methods research philosophy, this being both quantitative and qualitative as well as being underpinned by critical realism and interpretivism.

Within the structure of the chapter three (meta) themes can be identified. The first theme is the *research strategy.* The presentation of this theme includes a review of the relevant ontological perspectives and a description of the epistemological paradigms adopted for the present research. The second theme is that of the *research approach and methods.* In this section of the chapter, the consistency of the chosen *research approaches and methods* with the epistemological orientations is explained and there is a brief review of the literature from which the chosen methodology was developed. The third theme includes the *data collection* and *analytical and sampling methods* employed. This section of the chapter includes a discussion about the data sources and data types and the methods for selecting, collecting and analysing the data.

3.2 Research Strategy

In the present study, the justification of the acquisition of knowledge is regulated by the *research philosophy*, whereas the *research strategy*, including a series of methodological steps selected for the acquisition of that knowledge, is founded in ontological and epistemological assumptions. The topics *research philosophy, research strategy, ontology and epistemology*, as further elaborated in the sub-sections of this chapter, are briefly presented in Table 11.

Table 11: Brief presentation of the topics research philosophy, research strategy, ontology and epistemology.

Topic	**Brief presentation**
Research philosophy	Practice and philosophy of the social sciences are connected activities; the research philosophy relates to the principles regulating the search for and acquisition of knowledge through a series of methodological steps.
Research strategy	Based on: (1) the nature of the research question; (2) extent of control over events; (3) focus on contemporary events.
Ontology	Social phenomena with an almost tangible reality independent of social actors vs. social phenomena with meanings that are invented and constructed.
Epistemology	In the natural sciences entities exist independent of what we believe; social sciences require a different logic and research procedure.

3.2.1 Research Philosophy

The philosophy of the social sciences comprises a broad domain which is difficult to define in either philosophical or social science terms, and, since many of the traditional concerns of philosophy have been taken over by the social sciences, it is doubtful that this domain can exist exclusively as a branch of pure philosophy. Drawing on the assumption that the *philosophy* of social science is an activity of a different order than the *practice* of social science, the relationship between the *philosophy* of social science and the *practice* of social science is the subject of a continuing discourse where three broad models can be recognised (Delanty and Strydom, 2010, p.1).

The first philosophy of the social sciences model is the *prescriptive* or *legislative model*. Proponents of this model view reflection on scientific activity as a second order activity, prescribing how science ought to be done, and where the philosophy of social science is not unlike the philosophy of science. This stance belongs to the hypothetico-deductive or deductive-nomological school of thought (Delanty and Strydom, 2010, p. 2).

In the second philosophy of the social sciences model, the philosophical reflection on social science is essentially *epistemological* - investigating the nature and truth of scientific knowledge. Proponents of this model view the philosophy of the social sciences as something that emerges from within the social science domain and for which philosophers are not responsible. According to this viewpoint, the reflection on social science is not/no longer the domain of philosophers but of social theorists who reflect on their domain from within the social science discipline (Delanty and Strydom, 2010, p. 2).

The third and most influential model today the *intrinsic connected model* views the *practice* of social science and the *philosophy* of social science as intrinsically connected activities leading to the demise of the division between the *practice* of social science and the *philosophy* of social science. This model draws on the recent emergence of multidisciplinarity. Proponents of this perspective view social scientists both as practitioners and philosophers of their discipline. This view relates the philosophy of social science to wider cognition and knowledge related issues (Delanty and Strydom, 2010, p. 3).

In the context of the *intrinsic connected model*, social scientists must reflect on how the research process is structured, how the research is conducted and how it is embedded in its larger context. Pivotal in these reflections are the general criteria of acceptability implied in the social science domain, these being composed of: (1) the criteria under which the research is carried out; (2) the criteria according to which contributions to knowledge are evaluated; (3) the criteria recognised by the wider scientific community. This stance therefore concerns the philosophy of social science in its broadest sense: "… the principles regulating the search for and acquisition of knowledge … through a series of … methodical steps" (Delanty and Strydom, 2010, p. 3).

Within the present research, the philosophical stance that the social scientist is both practitioner and philosopher of his discipline seems the most appropriate and provides the context in which the following research strategy is developed. Within the context of this *intrinsic connected model* in this section of the chapter there are considerations about how the empirical data is obtained, analysed and evaluated using the following criteria: (1) how is the research process *structured*; (2) how is the research *conducted*; (3) how are the contributions of the present research to knowledge *embedded* in the extant knowledge. This is explained in the next three sub-sections of the chapter.

3.2.2 Research Approach

Blaikie (2010, p. 18) maintains that "research strategies provide a logic, or a set of procedures for answering research questions, particularly 'what' and 'why' questions". It is likely that the most common choice when deciding on a research strategy in social sciences is between quantitative research and qualitative research, this also being an approach to answer the research question.

Here, quantitative research epitomises research strategies that encompass quantifications in the collection and an analysis of the data for the *purpose of testing* a hypothesis. Qualitative research, however, epitomises research strategies that emphasise words rather than numbers and is aimed at the *generation of theory* (Bryman, 2012, pp. 35-36).

A practical tool to guide decisions about which research approach and method to choose is presented in Table 12. The table indicates how three basic conditions relate to five major research methods. These basic conditions are:

(1) the form of the research question; (2) the extent of control over behavioural events; (3) the degree of focus on contemporary events.

Table 12: Relevant situations for different research methods

METHOD	**Form of research question**	**Requires control of behavioural events?**	**Focuses on contemporary events?**
Experiment	how, why?	yes	yes
Survey	who, what, where, how many, how much?	no	yes
Archival analysis	who, what, where, how many, how much?	no	yes/no
History	how, why?	no	no
Field interview	how, why?	no	yes

Adapted from Yin, 2009, p. 8.

The topic of the present study focuses on contemporary rather than historical events where the topic of the study is of such a large scale and complexity that it cannot be manipulated by the investigator in the course of the investigation. The research question as formulated in Section 1.4 of this thesis reads:

> *Can we employ a broad framework, well embedded in the management literature, that explains the impact of the determinants on university competitive advantage generated by research and helps to understand the dynamic process by which university competitive advantage generated by research is created and upgrading is enabled so that university policy makers' strategic objectives can be more effectively met?*

The research question comprises two different sub-questions: the first sub-question involves explaining the impact of the determinants on university competitive advantage, this being a *how many?* or *how much?* question with the emphasis on quantification in the collection and analysis of the data. Answering this sub-question involves hypotheses testing and points to a *survey* or *archival analysis* as a research method. The second sub-question concerns understanding the process by which university competitive advantage in research develops. This is a *how?* question, emphasising the generation of a *middle range theory* (Bryman, 2012, p. 21) which is more *explanatory* and points to the use of a field interview approach. In short, indicates the outcome of using Table 12 for the selection of the best research method towards using quantitative and qualitative research methods in one project, namely mixed methods research.

Mixed methods research involving "… the collection, analysis and mixing of both quantitative and qualitative data in a single study or series of studies" (Blaikie, 2010, p. 218) is solidly based on the rejection of the quantitative/qualitative dichotomy. It has now become the third methodological movement with a defined set of methods and language and is subscribed to by an emerging community of practitioners and methodologists across a broad array of disciplines" (Tashakkori and Teddlie, 2010, pp. 271-272). A fundamental assumption of mixed method research in social sciences is that this approach might provide a better understanding of the topic under investigation than a dichotomous quantitative/qualitative approach (Tashakkori and Teddlie, 2010, p. 272).

Four major types of mixed methods research are presented in the literature: (1) *triangulation; (2) embedded*; (3) explanatory; (4) *exploratory types*. *Triangulation* involves comparing quantitative and qualitative data of equal weight within the same time frame. The *embedded* type of mixed methods research gives one type of data, usually qualitative data, a supplementary role in the design of the research and the elaboration of the procedures and/or the interpretation of the results, while in the *explanatory* type of mixed methods research, mixed methods research constitutes qualitative methods used to further elaborate on results which were formerly produced by quantitative methods. Moreover, in the *exploratory* type of mixed methods research, mixed methods research constitutes quantitative methods which are used to elaborate further on results that have been previously produced by qualitative methods (Blaikie, 2010, pp. 224-225). In the present research, an *explanatory* mixed method research approach has been chosen as this approach seems to fit the purpose of the present study best.

The classification of mixed methods research based on two criteria, *priority* and *sequence,* is one of a variety of ways to be found in the literature of classifying this kind of research. Key in this approach are the outcomes of two decisions: (1) the *priority decision* involving the principal data-gathering method (qualitative or quantitative); (2) the *sequence decision* ; this relates to which method precedes which or whether both methods were conducted more or less concurrently. The outcomes of these two decisions provide nine possible types of mixed methods research (Bryman, 2012, pp. 631-632). By drawing on the ubiquitous practice of using qualitative (peer review) approaches to assess research performance in higher education and bearing in mind the emergence of the limitations of quantitative (bibliometric) approaches from the literature review in the previous chapter, the decision was made to use the qualitative method as a principal data gathering method in this study. This was done in order to elaborate on the results, these being formerly produced by quantitative methods. It should be noted here that this choice allows for the outcomes of this study to be informed by the *language* and *understanding* of the social actors, whereas *numbers* are used to inform the practice. A more detailed elaboration highlighting the importance of the human dimension in the form of interview data over the *numbers* is presented in sub-section 3.2.4 of this chapter on epistemology. This is because the study does not limit itself to merely to modelling but truly mirrors the approaches within the discipline.

The process of a mixed methods approach comprises a number of successive steps: (1) the formulation of the research question; (2) methodological eclecticism – the consideration of the most diverse array of available methodological tools to answer the research question; (3) a selection of methodological tools that most effectively answers the research question; (4) an iterative, cyclical approach to the problem solving – constantly seeking a deeper understanding of the research problem (Tashakkori and Teddlie, 2010, p. 275). The formulation of the research question is presented in Section 1.4 of this thesis, while the consideration of methodological tools to answer the research question is the subject of the sub-section 3.3 of this chapter. The pursuit of a deeper understanding of the research problem is presented in Chapter 5 and Chapter 6 (dealing with the discussion, interpretation and reflection on the quantitative or qualitative findings respectively).

The mixed methods research strategy offering an approach well-embedded in the research literature is elaborated on in this sub-section of the chapter and matched against the following three criteria: (1) *structure* - how the research will be carried out; (2) *conduct* – how the contribution to knowledge will be evaluated; (3) *embedded* – how the contribution to knowledge will be recognised by the wider scientific community. This approach to research also provides a better understanding of the topic under investigation than a dichotomous quantitative/qualitative approach and should result in the wider scientific community recognising the contribution to knowledge.

In the following two sub-sections of the chapter, ontological choices (Are the social entities investigated in the present study objective entities with a reality external to the researcher or social constructions built upon the perceptions and actions of the researcher?) are discussed as are the epistemological choices (What is regarded as acceptable knowledge in social science?).

3.2.3 Ontology: Objectivism and Constructivism

The term ontology originates from the Greek word "*on"* meaning "*being"*, and "*logos"* meaning *theory* and refers to the inquiry into or theory of being (Delanty and Strydom 2010, p. 6). Gottfried Wilhelm von Leibniz (1646-1716), the German mathematician and philosopher, was the first major philosopher to adopt the word ontology (Mautner, 2000, p. 401). In social science inquiry, ontology concerns the nature and knowledge of social reality. An example of ontological questions are questions about the nature of *abstract entities* such as numbers, *imagined entities* such as golden mountains, and *impossible entities* such as square circles (Mautner, 2000, p. 401). For a variety of reasons, including those of language and history, an unequivocal circumscription of the term ontology is unavailable. Here, separate and isolated linguistic worlds make it impossible to capture the full range of meaning of the concept ontology. Additionally, the concept itself has a history and is continually undergoing change (Delanty and Strydom 2010, pp. 6-7).

Within the concept of *ontology*, there are two juxtaposed positions: *objectivism* and *constructivism*. O*bjectivism* is based on the separation of the subject and object of knowledge and the concept of the uninvolved observer (Delanty and Strydom 2010, p. 14). This implies that social phenomena have an almost tangible reality independent of social actors (Bryman, 2012, p. 33). *Constructivism* is the ontologically opposite position which asserts that knowledge is something that we produce where phenomena and meanings "… in an area of inquiry are not there to be discovered, but are invented or constructed" (Mautner, 2000, p. 111). More recently, *constructivism* has also included the notion that "… researchers' own accounts of the social world are constructions [and] the researcher always presents a specific version of social reality rather than one that can be regarded as definitive" (Bryman, 2012, p. 33).

The present research explores which determinants significantly impact university competitive advantage generated by research and their degree of (mutual) effect on performance. This enquiry can be claimed as a commitment to the *objectivistic* paradigm based on the assumption that the required data may be objectively collected and analysed. The enquiry in the present research into the dynamic process whereby university competitive advantage generated by research is created and upgrading is enabled is best facilitated within the *constructivism* paradigm, acknowledging that the researcher presents his version of reality and that acquiring *absolute* knowledge is indeterminable.

Most of the literature on performance measurement in higher education, as reviewed in section 2.4, present authors' versions of social reality, these constituting a commitment to constructionism; they are followed by papers presenting the outcomes of measurements which are a commitment to objectivism. Only a few papers in section 2.4 are a commitment to both paradigms. However, despite the latter category of papers representing a minority in the literature reviewed, it was felt that a commitment to both paradigms was required to facilitate the answering of the research question in the present study.

3.2.4 Epistemology: Critical Realism and Interpretivism

Epistemology is the theory of knowledge. It enquires into the nature and the possibility of knowledge and deals with the scope and limits of human knowledge, that is to say, how it is acquired and possessed. Investigations into the nature of knowledge focus on answering the question of what it means for someone to know that something is so (Mautner, 2000, p. 174). Central to the question about what can be regarded as acceptable knowledge in a particular discipline is the epistemological issue of whether the social world should be studied in a similar way to the natural science world (Bryman, 2012, p. 27). In the twentieth century, epistemology has experienced a shift from *positivism* and assumptions of the classical tradition into a recognition that "… knowledge is less about knowing reality than about emergent forms of the reality … [in a world] in which reality is shaped by cognitive practices, structures and processes" (Delanty and Strydom, 2010, p. 10).

Here, within epistemological assumptions, there are two juxtaposed positions*:* *positivism* and *interpretivism*.

*Positivi*sm is the epistemological stance that all knowledge is based on sense-experience and that there cannot be different kinds of knowledge. Genuine scientific enquiry should therefore be concerned with the description and explanation of empirical facts. Consequently, there should be no difference between the methods used in the natural sciences and those used in the social sciences (Mautner, 2000, p. 438). Proponents of positivism reject all theoretical or metaphysical knowledge that is not derived from experience, and they exclude value judgements from scientific knowledge because their validity cannot be tested by experience. They claim that anything that cannot by verified by experience is meaningless (Blaikie, 2010, p. 98).

Interpretivism is the juxtaposed position of positivism, and *interpretivists* share their objection to using a natural science approach in social sciences. Here, sociology as a field of inquiry is defined by Weber as: "*A science which attempts the interpretive understanding of social action in order thereby to arrive at a* *causal explanation of its course and effects"* (Crotty, 1998, p. 69). Within this context, the causation that social scientists seek to clarify is *causally adequate* "if on the basis of past experience it appears probable that a sequence of events will always occur in the same way" (Crotty, 1998, p. 69).

The philosopher Max Weber (1864-1920) contrasts *Verstehen* (understanding) in the social sciences with *Erklaeren* (explaining) in the natural sciences. However, he emphasises that *Verstehen* must be substantiated by empirical evidence. Here, the philosopher Rickert (1863-1936) also elaborates on the contrast between natural sciences and the social sciences, proposing "… that natural reality and social reality are in themselves different kinds of reality and their investigation therefore requires different methods"(Crotty, 1998, p. 67). The main contrasts between natural sciences and social sciences are summarised in Table 13.

Table 13: Main contrasts between natural sciences and social sciences

Natural sciences	**Social sciences**
Seeking consistencies, regularities, general 'laws'.	Isolating individual phenomena to trace their unique development
Seeking what is *nomothetic* (nomos = law)	Seeking what is *ideographic* (idios = individual)
Focus on phenomena that exhibit quantifiable, empirical regularities	Focus on qualitative aspects

Crotty, 1998, p. 68.

Interpretivism for some academics is used in reference to all non-hypothetico-deductive approaches in social sciences, whereas others maintain that qualitative research is itself characterised by an *interpretative* approach (Williams, 2000, p. 209). Interpretivists consider that "… social regularities can be understood, perhaps explained, by constructing models of typical meanings used by typical social actors engaged in typical courses of action in typical situations" (Blaikie, 2010, p. 99). In the *interpretivist* view, universities, as with other organisations, can be viewed as social sites inhabited by a special type of community which however shares significant characteristics with other types of organisations, like firms, for example (Alvesson and Deetz, 2010, p. 33). Although statistical generalisations have never been the purpose of *interpretivist* research, virtually every *interpretivist* study has some kind of generalising claim. Commenting on these issues, Williams (2000, p. 221) considers it is possible to generalise from *interpretivist* studies if they provide dense, detailed and contextualised descriptions, but he cautions that generalisations beyond the moderate are "objectively unjustified" (Williams, 2000, p. 221).

Interpretivist management studies often use *ethnography, hermeneutics* or *phenomenology* as a research method upon which to ground their largely qualitative methods. Methods used in such studies often comprise long-term observations and in-depth interviews (Alvesson and Deetz, 2010, p. 33).

Ethnography as a research method, which is largely employed by anthropologists but also by sociologists, uses observations about the activities of a particular group of people to describe and evaluate these activities (Abercrombie et al., 2000, p. 123). The aim of ethnography as a research method is "… to 'get inside' the way each group of people sees the world" (Hammersley, 1985, cited in Crotty, 1998, p. 76). Ethnography as a research method fits within the *symbolic interactionist* theoretical sociological perspective, this drawing on the work of Mead (1863-1931) and enunciating the following three basic assumptions:

- Human beings act toward things on the basis of the meaning that these things have for them;
- The meaning of such things is derived from, and arises out of, the social interaction that one has with one's fellows;
- These meanings are dealt with and modified through an interpretive process used by a person when dealing with the things he/she encounters.

Crotty, 1998, p. 72.

The central notion of symbolic interactionism which informs research methodologies places one person in the position of the another. From a methodological point of view, symbolic interactionist researchers must "… accept the meanings that the actors attribute to social phenomena at face value, and proceed to erect their systematic interpretations on these foundations. This implies that the sociological observer must … ensure that it is indeed the *actors'* meanings that are recorded … and not merely his[/her] own" (Mitchell, 1977, cited in Crotty, 1998, p. 75).

The central notion of symbolic interactionism where "… only through dialogue can one become aware of the perceptions, feelings and attributes of others and interpret their meanings and intent" (Crotty, 1998, pp. 75-76) certainly has relevance for the present study. However, while ethnography is taken by symbolic interactionism "to its bosom" (Crotty, 1998, p. 76) as "… a research method in which the researcher immerses him- or herself in a social setting for an extended period of time" (Bryman, 2012, p. 711), this method has not been selected here. The reason for this is because it was impossible for the researcher to spend *an extended period of time* at a number of German universities.

*Phenomenolo*gy is also an anti-positivist position and draws on a philosophical method and movement, attempting to describe experience directly as it is. The term *phenomenology* appeared to be used for the first time in 1764 for an enquiry into sensory experience and how things seem to be (Mautner, 2000, p. 421). *Phenomenology* has entered sociology mainly through the work of Alfred Schutz 1899-1959). He claimed that the beings living in the field of enquiry of a social scientist have pre-selected and pre-interpreted the world they experience as their daily reality and that it is these thought objects which determine their behaviour by motivating it. Schutz suggested that the scientific knowledge produced by social scientists to grasp this social reality should be founded upon the everyday knowledge produced by the individuals living in that social world (Bryman, 2012, p. 30).

Generally speaking, phenomenology is "a study of people's subjective and everyday experience … from the 'point of view' or 'perspective' of the subject" (Crotty, 1998, p. 83). Here, *experience* is interchangeable with *phenomenon*. The advantages of phenomenology as research approach are that "… if we lay aside … the prevailing understandings of those phenomena and revisit our immediate experience of them, possibilities for new meaning emerge for us or we witness at least an authentication and enhancement of former meaning" (Crotty, 1998, p. 78). Phenomenology makes it necessary for the social science researcher to allow the experience of phenomena to speak to her/him directly. Phenomenological researchers should therefore gather data through field interviews ensuring that the themes are not imposed on the interviewees but emerge from the interview data. They should also make it possible for the interviewees and others to show that the themes are genuinely found in the data.

Here, what is relevant for the study is how phenomenology highlights the difference between a *reality* and any *concept* of it, this being very similar to the differences between an *object* and any *measurements* of it (see Section 2.3.1). Very relevant for this study is that phenomenologicalists highlighted how “a concept is never able to exhaust the richness of a phenomenon … [since] there is always an element that the concept fails to express” (Crotty, 1998, p. 81) so leaving a gap between the phenomenon and its abstraction.

Hermeneutics is defined as “a method for deciphering indirect meaning, a reflective practice of unmasking hidden meanings beneath apparent ones” (Crotty, 1998, p. 88). It is the science of biblical interpretation and came into modern use in the seventeenth century. Hermeneutics comprises a complexus of theories, principles, rules and methods, these being employed to explain what a biblical text means. In the course of time, hermeneutics has migrated into many scholarly disciplines, not merely to understand a text but also to investigate unwritten sources. Here, an enduring theme within hermeneutics is the approach of relating a part to the whole and the whole to a part.

Hermeneuticians agree with the opponents of *positivism* that there are significant differences between the study of human action and the study of the natural sciences and that the former requires special research methods. Two such methods include: (1) focusing on the relationship between the creator of an act and the interpreter of that act so that the interpreter understands the behaviour of the creator by putting himself in the position of the creator; (2) disregarding of the characteristics of the individual and understanding human action in relation to a *wider whole,* for example, a world view which gives it meaning (Abercrombie, Hill and Turner, 2000, p. 163).

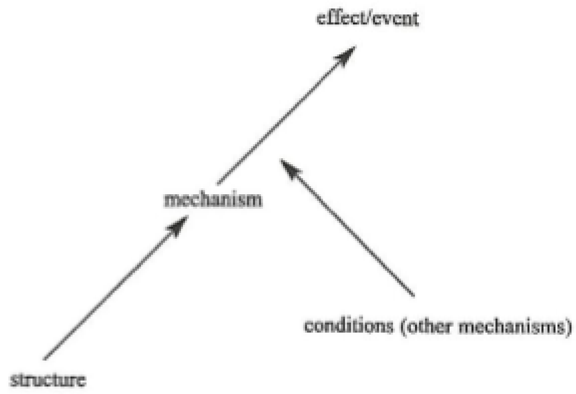
Within the *interpretivist* epistemological stance an interpretation can be found on three levels: (1) the level of the interpretation by the individuals living inside their social context; (2) the level of interpretation by the researchers providing an interpretation of the others' interpretations; (3) further interpretations by others in terms of the concepts, theories and the literature of the social sciences (Bryman, 2012, p.31).

Hermeneutics as a research method certainly has potential in the present study as an approach to the qualitative analysis of written texts. For example to analyse magazine, newspaper and journal articles about the universities included in this study. However, the *Relevant situations for different research methods* grid, as presented in Table 12 of this chapter, points towards using *archival analysis* to collect quantitative data and to a *field interviews* approach to collect qualitative data. In this context is hermeneutics less appropriate for analysing written accounts of interviews.

Realism is juxtaposed with positivism and interpretivism. Realist theory draws on the view that entities exist independently of what we believe or feel about them (Mautner, 2000, p. 472). Fundamental in *realism* is the distinction between *intransitive* and *transitive* dimensions of knowledge as made by Bhaskar (1975). Here, the objects of science themselves form the *intransitive* dimension of science and the theories and discourses about them form the *transitive* dimension. The relationship between *intransitive* and *transitive* dimensions is presented in the following example: "There is no reason to believe that the shift from a flat earth theory to a round earth theory [*transitive* dimension] was accompanied by a change in the shape of the earth itself [*intransitive* dimension] (Sayer, 2000, p.11). *Realism* further contrasts with *idealism*, the latter being "the philosophical view that what is real is somehow confined to what is in the mind, that is, it consists only of 'ideas' (Crotty, 1998, p. 64).

A key element of *realism* is the analysis of causation. *Realists* reject the common *successionist* practice to prove causation by gathering data on repeated incidents or events. The critical realist view of causation is depicted in Figure 24.

Figure 33: Critical realist view of causation.



Sayer, 2000, p. 15.

In the *critical realist* model of causation, *structure* refers to a set of internally related objects whose combined causal powers emerge from those of their constituents. Here, *conditions* influence how the same causal power can lead to different outcomes. For example, economic decline can lead to restructuring and innovation but also to the closure of firms. However, different causal *mechanisms* can lead to the same result. For example, there are many reasons why a person might lose his/her job. Taking the view that events are not predetermined before they occur indicates the model where outcomes depend on contingent conditions they can end in a variety of ways (Sayer, 2000, p. 15). *Explanation* in the context of *realism* is the "… uncovering [of] the (real) underlying and often unobservable mechanisms that connect phenomena causally" (Abercrombie, Hill and Turner, 2000, p. 290).

Drawing on the research question and the presentation of the epistemological stances in this sub-section of the paragraph seems a *realist* stance best suited to uncover the connections between the determinants of academic research performance and actual *performance.* It should be noted here that *realism* along with positivism and interpretivism is compatible with a large range of research methods.

In this study, the key criterion among the considerations regarding epistemological issues is that the outcome of these considerations provides an acceptable context for knowledge to be acquired. A brief summary of the key considerations as emerging from this sub-section of the chapter is presented in Table 14.

Table 14: Considerations regarding epistemological issues in the present research.

Epistemological assumption	**Research method**	**Considerations in order to answer the research question**
Positivism: enquiry is concerned with description and an explanation of empirical facts.	Natural sciences research methods: quantitative / statistical methods	A positivistic approach is suitable to explain the impact of the determinants on university competitive advantage, but seems less appropriate to understand causal relationships.
Interpretivism: enquiry is characterised by an interpretitive approach using qualitative research methods - opposes the positivism of the natural sciences.	*Symbolic interaction* accepts the meanings that social actors attribute to social phenomena at face value and build its systematic interpretations on these foundations. Ethnography, as the main interactionist research method and born to anthropology comprises the description and evaluation of long-time observations.	Ethnography because it requires long-time observations does not seem to offer a plausible research method to understand the process of creating and upgrading competitiveness in research.
As above.	*Hermeneutics*: “a method for deciphering indirect meaning, a	Placing research results in a wider context for example through

	reflective practice of unmasking hidden meanings beneath apparent ones" (Crotty, 1998, p. 88) offers an explanation of what a (biblical) text means.	'reading' written and/or unwritten sources does not seem to offer a plausible research method to understand the process of creating and upgrading competitiveness generated by research.
As above.	*Phenomenology*: attempts to understand the social actors' interpretations by conducting interviews and organising and analysing the data into a coherent portrayal of the topic investigated and elaborating on interpretations from the literature.	A phenomenological approach allows to collect and analyse data in a way not prejudiced by the researcher's presuppositions to develop a fresh and unprejudiced understanding of the process of creating and upgrading a university's competitive advantage.
Realism: underlines the reality of social constructions. *Critical realism* allows explanation of the underlying and often unobservable mechanisms that connect phenomena causally.	Comparable with a wide range of positivism and interpretivism research methods.	The *critical realist* model of causation offers a structure for a set of internally related objects (determinants of research performance) whose combined causal powers are emergent (performance outcomes).

In short, what emerges from this sub-section is that the author adheres to an *interpretivist* stance where the enquiry into social science requires different research procedures from an enquiry into natural sciences. Of the three main streams in the interpretivist approach to the human inquiry considered, namely symbolic interaction (ethnography), hermeneutics and phenomenology, the latter approach suits the purposes of this study best; the phenomenological approach requires the researcher to engage with the social actors and the phenomena being examined to make sense of them directly and immediately.

A mixed methods approach, using a qualitative method as the principal data gathering method to elaborate on results that were formerly produced by quantitative methods comprising a critical *realist* approach to uncover the connections between the determinants of academic research performance and the actual *performance* and a *phenomenology* approach to develop a fresh and unprejudiced understanding of the process of creating and upgrading a university's competitive advantage articulates the importance of the human dimension vis-à-vis the 'numbers'. Such an approach not only mirrors the practice (in the private and public sector) in the discipline but also precludes the possibility of the study being limited to modelling only.

The *realist* and *interpretivist* epistemological stances discussed in this sub-section of the chapter provide the theoretical perspective that informs a range of methodologies; they also make it possible to justify the choice of the research approach and the use of the methods presented in the following sub-sections of the chapter. The particular choices made in the next sub-section of this chapter depend on the nature of the objects under investigation and what knowledge may be gained from them.

3.3 Research Approach and Methods

The concept of *research approach* is used for various purposes in the research literature. It should be noted that the usage of this concept in the present study focusses on the major logics of social inquiry Here, research approach is interchangeable with research strategy. As explained in section 3.2.1 of this chapter, in the present study a *mixed-methods* research approach is adopted, including quantitative and qualitative research methods. In the relationship between the collection and analysis of the relevant data and theory, four approaches can be distinguished, as shown in Table 15.

Table 15: Research approaches.

Approach	Main characteristics
Abductive	Abductive research methods are qualitative research methods which involve the construction of theories, these being founded on everyday activities and in the language and meanings of social actors (Ong, 2012, p. 422). The aim of abductive research methods is "… to describe and understand social life in terms of social actors' meanings and motives" (Blaikie, 2010, p. 84).
Deductive	"Deductive reasoning [is] the logical process of deriving a conclusion from a known premise or something known to be true" (Zikmund, 2000, p. 43). A deductive approach, often associated with quantitative research, includes the formulation of a hypothesis that must be subjected to empirical scrutiny (Bryman, 2012, p. 24).
Inductive	"Inductive reasoning [is] the logical process of establishing a general proposition on the basis of observation of particular facts" (Zikmund, 2000, p. 43). With an inductive approach, this being typically associated with qualitative research, generalizable inferences are the outcome of the inductive process that begins with the observations or findings (Bryman, 2012, pp. 26-27).
Retroductive	"Retroductive inference is built on the premise that social reality consists of structures and internally related objects but that we can only attain knowledge of this social reality if we go beyond what is empirically observable by asking questions about and developing concepts that are fundamental to the phenomena under study" (Meyer and Lunnay, 2013, p. 3). The aim of retroductive research is to "… discover underlying mechanisms to explain observed regularities" (Blaikie, 2010, p. 84).

Adapted from Blaikie, 2010, p. 84.

Within the present research, a deductive approach for the analysis of the outcomes of quantitative research methods seems the most appropriate as well as an abductive approach for the analysis of the outcomes of qualitative research methods, this being explained in the next two sub-sections of the chapter.

3.3.1 Deduction

A deductive approach seeks to test hypotheses, after which a theory is confirmed, refuted or modified. In the present research, with the hypotheses representing assertions about the relationships between *determinant*s of competitive advantage in academic research and university *performance* in research, the *determinants* and *performance* are the founding elements of the hypothesis. The first step in the deductive process, as presented in Table 16, is the development of a statement about the relationship between a determinant and performance, this being subsequently tested through the application of statistical methods. Pivotal in the process here is that measurable indicators of the determinants are present. Consequently, only data about *determinants* that could be quantified, is collected and measured (Gray, 2013, pp. 16-17). The methods for data collection and analysis employed in the deductive process are presented in the next sub-section of this chapter.

Table 16: Summary of the deductive process.

Stages in the deductive process	**Actions taken**
Theory	Select a theory or set of theories most appropriate for the subject under investigation.
Hypothesis	Produce a hypothesis (a testable proposition about the relationship between two or more concepts).
Operationalize	Specify what the researcher must do to measure a concept.
Testing by corroboration or attempted falsification	Compare observable data with the theory. If corroborated, the theory is assumed to have been established.
Examine outcomes	Accept or reject the hypothesis from the outcomes.

Modify theory (if necessary)	Modify theory if the hypothesis is rejected.

Adapted from Gray, 2013, p. 17.

3.3.2 Abduction

The key characteristic of abductive research is that it enables social science researchers to refine and redevelop theory. The crucial difference between *abduction* and *deduction* is that "… abduction shows how something might be whereas deduction proves that something must be a certain way" (Meyer and Lunnay, 2013, p. 3). An abductive approach seeks to generate theory which is based on the meanings of social actors from social actors' accounts (Ong, 2012, p. 425). For this purpose, the social science researcher enters the world of the social actors and draws on the same *mutual knowledge* that social actors use. Here, the process of theory construction begins by describing the meanings of the social actors, this being followed by deriving categories and concepts from the meanings which then form the foundation of understanding as described in detail in Section 3.4.4 of this chapter. The next step in the process involves the social researcher supplementing the understanding derived from the social actors with her/his own knowledge. Here, the combination of the social researcher's own knowledge together with the knowledge derived from the social actors provides rich answers to the research question (Blaikie, 2010, pp. 89-92). The steps in the *abductive process* are presented in Table 17.

Table 17: Summary of the abductive process.

Stages in the abduction process
General formulation of the problem to be studied.
Relevant literature is reviewed even although its relevance is hard to ascertain at this stage.
It is necessary to become part of the social actors' world by regular involvement with them.
The social actors' world is entered with sensitizing concepts being used as a guide, these being as non-directive as possible.

The concepts and categories used in the discussion of the *topic* are identified.
The meaning of these concepts and categories is explored.
All the comments and behaviour with associations regarding the central concepts are recorded.
The problem is refined and narrowed.
The concepts and categories from one social actor to the other social actors are identified.
The relevance and usefulness of the social actors' concepts in the relevant literature are checked.
This is continued until a theory is established.

Adapted from Ong, 2012, p. 425.

The relationship between abductive research and theory generation is captured in Layder's (1998) *adaptive theory* paradigm which appears to be highly appropriate as regards the present study because "… adaptive theory focusses on the construction of novel theory in the context of ongoing research by utilising elements of prior theory" (Blaikie, 2010, p. 147). In the present study, *prior theory refers* to Porter's *four stages of competitive development* model (see Section 2.4.1. of this thesis), this prior theory being adapted in an interchange with the novel theory emerging from the interviewees' responses.

3.4 Data Collection and Analytical and Sampling Methods

The choice of the data collection method used in the present research is mainly based on the outcome of the use of the *Relevant situations for different research method*s grid, as presented in Table 12 of this chapter. Here, the outcome points towards *archival analysis* as well as field interviews as data collection methods.

3.4.1 Data Collection: Archival Analysis

Archival analysis as used in the present study involves the use of secondary data that has been collected by German universities and made available via the Internet and publications such as Annual Reports. Here, secondary data is selected as a source for quantitative data concerning a number of aspects of university performance since it provides the opportunity for access to good-quality data for a fraction of the time and resources involved when the data collection has to be carried out by the author (Bryman, 2012, p. 312). Further, it is assumed that the universities that gathered the data have structures and control procedures in place to check the reliability and validity of the collected data (Bryman, 2012, p. 313). The limitations of using secondary data include aspects of reliability and validity. Definitions and policies regarding the collection of the data may vary over time and/or over the universities, resulting in a situation where the same indicator may measure different things. For example, it seems there is no uniformity about staff categories. This prompts the question of whether *academic staff* only includes full tenured staff or PhD-students as well. Similarly with *research income*, it is unclear if this exclusively refers to external research funding or also includes research funding from the universities' basic budgets.

3.4.2 Data Collection: Multiple Semi-Structured Interviews

The outcome of using the *Relevant situations for different research methods* grid in this study indicates the use of a *survey* or *archival analysis* approach as the research strategy to answer the '*how many?'* or '*how much?'* aspects of the research question and the use of the *field interview* approach to address the '*how?'* and '*why?'* aspects of the research question (see Section 3.2.2). Following this outcome, the *field interview* approach in the present research supplements the insights attained using a *survey* or *archival analysis* approach This came about because of a need to understand the complex phenomenon of academic research performance.

In this study the aim of the field interviews is to develop an understanding of how competitive advantage created by research comes into being and how upgrading is enabled. In qualitative research and within a phenomenological context, interviewers should ensure that themes are not imposed on the interviewees but rather should emerge from the interview data. They should ask interviewees “their opinions about events … even ask the interviewee to propose her or his own insights into certain occurrences”(Yin, 2009, p. 107). For the researcher in this study, the interviewee is seen as an *informant* and is critical to the success of the investigation. Such *informants* can provide insights and initiate access to corroborate or contradict evidence.

The format that best ensures an emphasis on the interviewees’ own perspectives is the *semi-structured interview.* Here, there is a growing tendency in the literature to refer to *semi-structured interviews* as *in-depth interviews* or *qualitative interviews.* Pivotal to semi-structured interviews is the fact that this data collection method makes it possible to follow-up on significant issues that have emerged during the interview. A further advantage of using multiple interviews is that the evidence is often more compelling than it would be in a single interview because multiple interviews can be considered as narratives of multiple experiments.

In this study, the first step in the multiple-interview approach is the development of a theory. Here, Porter’s *four stages of competitive development* theory (see Section 2.4.1 of this thesis) is used. The next two steps include the selection of universities to be interviewed (this being discussed in greater detail in Section 3.4.6. of this chapter) and the design of the data collection protocol. In the present research, the latter is an *interview guide* and includes a brief list of the issues to be addressed in the interviews. Following this, the interviews are held and individual reports are prepared for each interview. The conclusions from each preceding interview are considered to direct (in part) the next interview. In the analysing and concluding phase of the multiple-interview process, the results of all the interviews are compared and contrasted to find the convergent evidence of Porter’s model or to discover evidence to modify the model (adapted from Yin, 2009, p. 56).

A potential weakness when using interviewing as a research method is that the interview data must always be considered as a verbal report and is therefore subject to bias, inferior recall and poor or inaccurate articulation. Even when the same thoughts emerge from different interviews, the researcher must exercise caution (Yin, 2009, pp. 107-109). For this purpose in this study, an effort was made to include interviewees from universities at different stages of competitive development and where there were likely to be different perspectives. Also the possibility of corroborating interview data with information from other sources was used in this study.

3.4.3 Analytical Methods: Quantitative Data Analysis - Central Tendency, Correlation and Regression

The aim of employing *descriptive* statistics in the present research is to examine the quantitative data from the universities in the sample in some detail in order to attain a general impression of what the data has to say. This is achieved through the presentation of the data scores in graphs, the calculation of means, averages and other measures of central tendency, and the identification of oddly shaped distribution of scores and extreme scores (Howell, 2010, p. 5). Descriptive statistics are looked upon by some statisticians as ".. a rather uninteresting field populated by those who draw distorted-looking graphs" (Howell, 2010, p. 5). However, a close examination of the data before employing more complex statistical procedures has gained popularity since the 1980s, drawing on the development of the *exploratory data analysis* concept by John Tukey, this being described as "an attitude, a flexibility, and a reliance on display, NOT a bundle of techniques" (Tukey, 1980, p. 23). Here, *exploratory data analysis* seeks to helping social science researchers understand the data. The philosophical justification for *exploratory data analysis* is found in the concept of *abduction* (Behrens and Yu, 2003, p. 33). Abduction as research approach is presented earlier in Section 3.3.2 of this chapter.

The aim of using *histograms* in this study is to group adjacent values together in order to present important trends in the data. In the histograms, the data is grouped in blocks, including all the values between the lower and upper limit of the block and these are depicted against the frequency of all the values within each block. Histograms can come in various shapes: a *normal distribution* is depicted as a symmetrical curve around the centre of the distribution, and a thinning off at both ends; a *bimodal* distribution shows two peaks; a *negatively skewed* curve shows a tail going out to the left and a *positively skewed* curve in a tail going out to the right (Howell, 2010, pp. 27-28). Here, the *positively skewed* curve of academic research performance shows that a higher level of performance is found by fewer universities.

The aim of calculating the *mean* is to show the central tendency in the data, this being the sum of the scores divided by the number of scores (Howell, 2010, p. 33). The purpose of presenting the *standard deviation* is to present a measure of *variability* by means of the average of the deviations of each score from the *mean.* For a *normal distribution* fall about two-thirds of the observations within one standard deviation (Howell, 2010, p. 42). The aim of calculating the *mode* is to show the *most common score*. The *mode* is the score obtained from the largest number of subjects and is depicted as the highest block in the histogram. A *bimoda*l or *multimodal* distribution refers to the occurrence of two or more non-adjacent cores with (almost) equal frequency (Howell, 2010, p. 32). A *bimoda*l or *multimodal* distribution suggests that the sample members belong to different clusters. In this study is the method of *k-Means Cluster Analysis* used to group sample members into clusters so that universities in the same cluster resemble each more than universities in other clusters. This method was developed in the late 1960s by MacQueen and is a fundamental data reduction technique used in the social and physical sciences. In this approach, the number of clusters is decided prior to the analysis and data points are randomly selected as initial estimates of the cluster centres. The remaining data points are assigned to the closest data centre on the basis of the distance between them with the aim of obtaining the maximum homogeneity between the clusters (Voges, 2009, p. 561).

The aim of *inferential* statistics in the present research is to infer something about the characteristics of all German universities from what we know about the characteristics of the universities in the sample (Howell, 2010, p. 5).

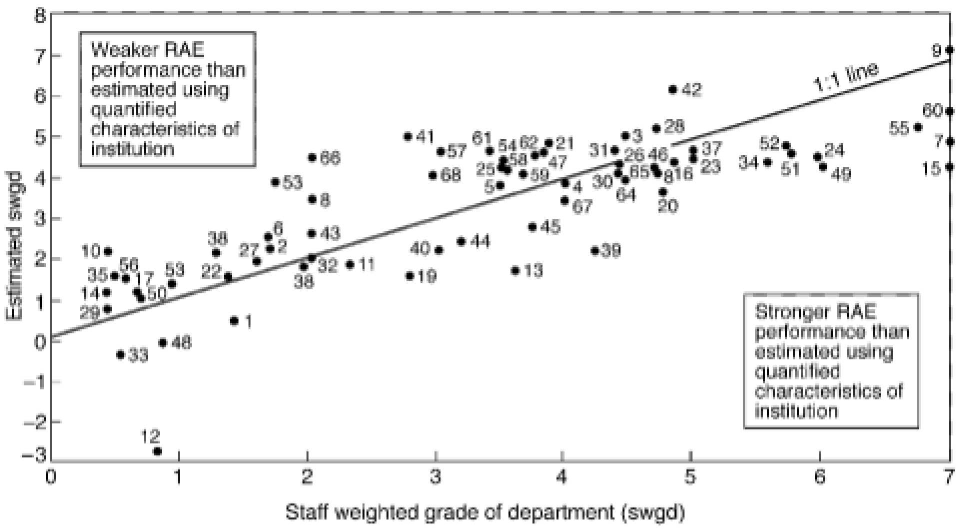
The purpose of *regression* analysis is to facilitate the prediction of the dependent variable Y on the basis of the independent variable X. *Regression* analysis makes it possible to test hypotheses where causality is asserted (Acton and Miller, 2009, p. 209). The purpose of *correlation* analysis is to obtain a statistic expression of the *degree of relationship* between two (or more) variables (Howell, 2010, p. 246). In the regression analyses in the present research, the dependent variable research performance is expressed by the number of publications in a five-year period, and the independent variable is one of the tested determinants of the condition of each of the corners of Porter's diamond (see Section 2.4.1). Prior to multiple regression analyses, *Null-hypotheses*[21] are tested using *simple regression analysis.* Here, the degree of the relationship between the variables is presented by the *Pearson Product-Moment Correlation Coefficient (r),* with a possible value between -1 and 1. A close value of *r* to these limits indicates a strong relationship (Howell, 2010, p. 252). The second measure of *correlation R Square* expresses the percentage of shared variation – the variance in the dependent variable being explained by the independent variable (Howell, 2010, p. 264 and Acton and Miller, 2009, p. 210). The aim of *stepwise multiple regression analyses* in the present research is to allow the prediction of the dependent variable Y on the basis of the *combined* effect of all the relevant independent variables. In such a *stepwise multiple regression analysis,* new variables are added step by step, and the included variables are dropped if their correlation coefficients become non-significant because of the effects of other variables (Acton and Miller, 2009, p. 223). The outcome of the *stepwise multiple regression analyses* are *regression equations* which make it possible to express the value of the dependent variable numerically.

The technique of a *scatterplot* is used in the present research to identify under-par, on-par, and above-par performing universities vis-à-vis their peers in the sample. In the scatterplot in Figure 25, the predictor variable (actual performance) is represented on the X-axis, with the criterion variable (estimated performance) on the Y-axis. Here, the regression line represents those subjects in the sample where the actual performance equals the estimated performance

[21] As we can never prove a hypothesis to be true, we prove that the Null Hypothesis, a hypothesis that is the direct opposite of what we hope to show, is false (Howell, 2010, pp. 92-93).

– the *on-par* performers. *Above-par* performers are those subjects in the sample with an actual performance > estimated performance, these being depicted below the regression line, and *below-par* performers with an actual performance < estimated performance are depicted above the regression line (see Section 2.4.2).

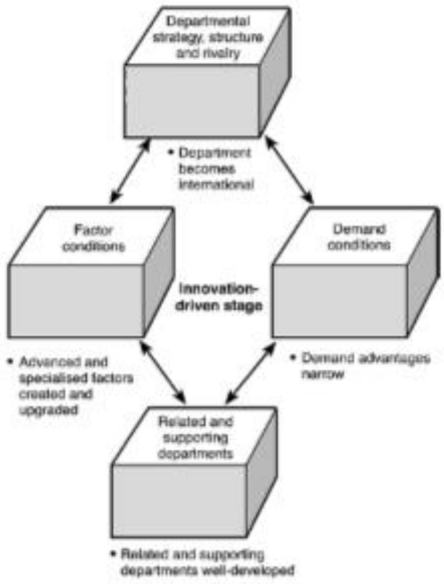
Figure 25: Scatterplot of actual and predicted performance identifying under-par, on-par and above-par performers



Curran, 2001, p. 243.

The purpose of creating four scatterplots is to establish that the positions of a university in the sample in each of the four scatterplots corresponds to the condition of each of the four corners of the diamond of that university. For example, in the present research is the condition of the diamond of a university in the sample which is positioned in all four scatterplots below the regression line (= above-par performer on all corners) depicted as in Figure 26. Here, the condition of the diamond of such a university is congruent with the diamond in the *innovation-driven* stage of competitive development (see section 2.4.1).

Figure 26: Condition of the diamond of a subject in the sample, which is positioned in all four scatterplots below the regression line.



Detail from Curran, 2001, p. 247.

3.4.4 Analytical Methods: Qualitative Data Analysis – Thematic Analysis

Thematic analysis is a widely employed qualitative analytical method and although often framed as a an realist experimental method, compatible with constructionist paradigms used to identify, analyse and report themes within the research data (Braun and Clarke, 2006, pp. 78-79). Here, the thematic analysis when employed to make the participants' reality transparent fits well within a *constructivist* context where the thematic analyst can theorise meaning in a straightforward way. With a *semantic approach,* the *thematic analysis* progresses from *description* - so that the data is organised and summarised in such a manner that patterns emerge - to *interpretation.* Here, an effort is made to theorise the importance of the patterns that have emerged and their broader meanings and implications, often in relation to previous theory (Braun and Clarke, 2006, p. 84). *Thematic analysis* differs from quantitative methods because more instances of a theme in the data set do not necessarily mean that a theme is more important; this is dependent on whether it captures something important in relation to the research question (Braun and Clarke, 2006, p. 82). Table 18 presents the six phases of *thematic analysis*.

Table 18: The six phases of thematic analysis.

Phase:	**Description of the process**
Familiarising with the data.	Transcription of the data and generation of initial ideas which may lead to initial codes.
Generation of initial codes.	Systematic coding of interesting features across the data set.
Search for themes.	Sorting initial codes into potential themes and gathering of all data relevant to each potential theme. Creation of an initial thematic map.
Review of the themes.	Assessment of the relationship between themes and the coded extracts; generation of a final *thematic map* of the analysis
Defining and naming of the themes.	Generation of clear definitions and names for the themes, identifying the essence of each theme. Provision of a detailed analysis for each theme.
Reporting.	Provision of an account of the story the data tells and relating the analysis back to the research question and the extant literature.

Adapted from Braun and Clarke, 2006, p. 87.

In the present research, *thematic analysis* is used to identify, analyse and report the findings from the semi-structured interview.

3.4.5 Sampling Method: Unobtrusive Method – Archival Data

The use of archival data in the present research draws on the assumption that whenever people know they are participating in a study their replies will most likely be influenced (*reactive data)*. By using *archival data*, an *unobtrusive* *method* of data collection whereby the investigator is separated from the subject of her/his study, the occurrence of *reactive data is* avoided. However, the investigator should not forget that the data was originally collected/produced for a purpose which may have influenced the data collection (Bryman, 2012, pp. 325-326). See also Section 3.4.1 of this chapter.

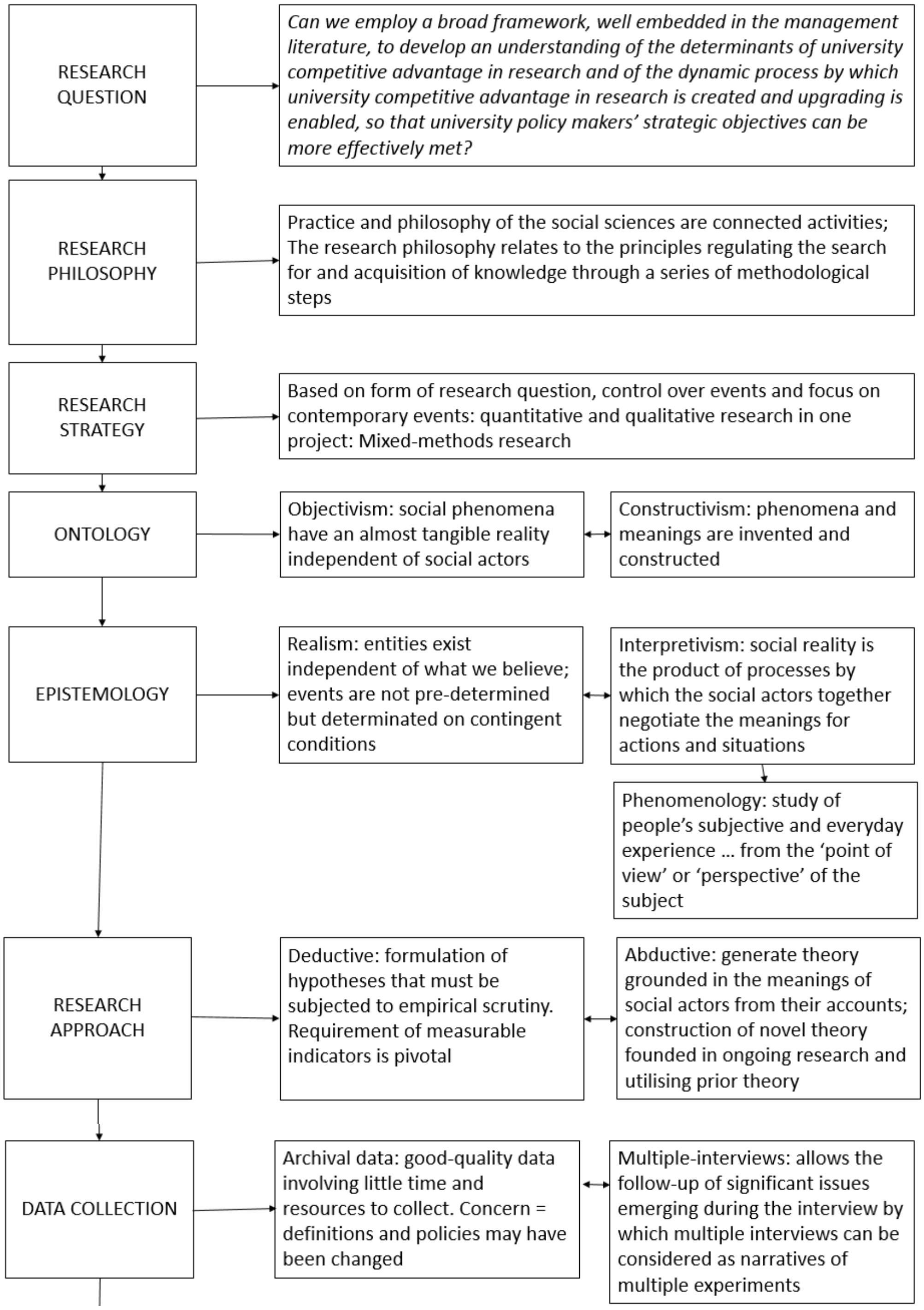
3.4.6 Sampling Method: Purposive Sampling of Multiple Interviews

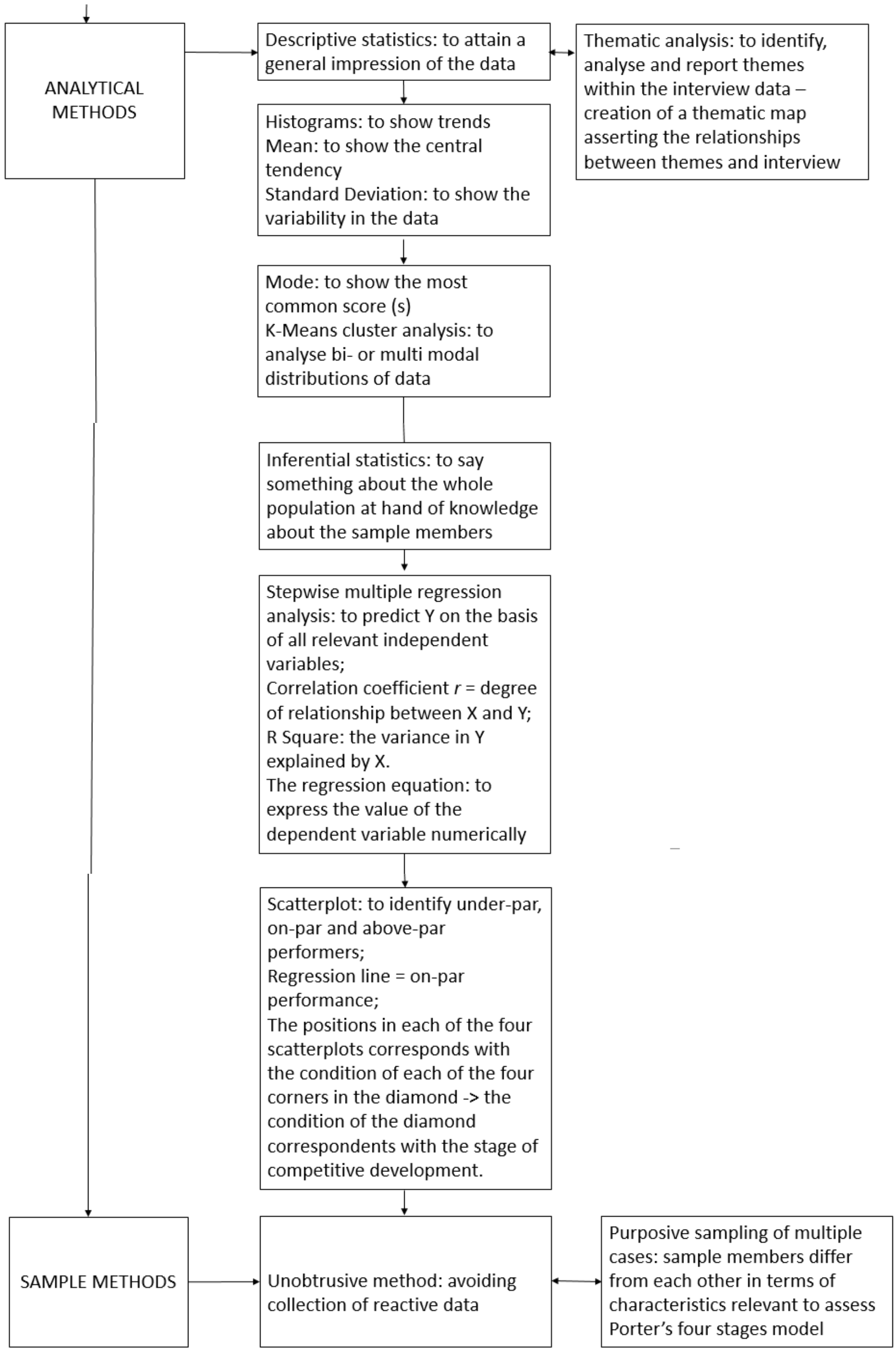
The use of multiple interviews in the present research draws on the assumption that the *replication logic* in multiple interviews is analogous to that in multiple experiments. It should be noted here that *replication logic* is different from the *sampling logic* of surveys. While the procedure of a survey is to determine the prevalence of a particular phenomenon in an entire universe, using multiple interviews for this purpose would require an impossibly large number of interviews (Ying, 2009, p. 56). The sampling of interviews aims to predict similar results (*literal replication)* or to predict contrasting results *(theoretical replication)*. When the aim is *literal replication,* the sample should include 2-3 interviews; when the aim is *theoretical replication,* the sample size should be 4-6 interviews, this implies however that the selection of the interviews requires prior knowledge of the outcomes (Ying, 2009, pp. 54 and 59).

Purposive sampling is used in the present research to select the most appropriate candidates for in-depth interviewing (Blaikie, 2010, p. 178). The aim of sampling the interviewees is to include representatives of universities at different stages of competitive development (see Section 2.4.1 of this thesis), this being achieved best with the *purposive sampling* method*.* "*Purposive sampling* is a non-probability form of sampling … with the goal … to ensure that there is a good deal of variety in the resulting sample, so that sample members differ from each other in terms of key characteristics relevant to the research question" (Bryman, 2012, p. 418). The sampling of interviewees in the present research draws on the outcomes of the quantitative data analysis, providing information about the condition of the diamond of the universities in the sample which relates to their stage of competitive development. In the event of some of the selected cases producing results which are incongruent with Porter's model, this leads to a modification of the model with the aim of adapting the model for use in German higher education.

3.5 Concluding Remarks

Figure 27: Elements of the research design.





Adapted from Blaikie, 2010, p. 33.

In summary, this chapter describes the research philosophy, the approach, the design and methods that are used to advance the knowledge of the assessment of academic research performance in German higher education. The research design is developed with the objective of operationalising the examination of the research question. The structure of the research design is depicted in Figure

28. It is important to note that the connections between the elements of the centre column and the right column are shown in double-headed arrows for the sole purpose of distinguishing the quantitative from the qualitative elements of the design and in no manner highlight any dichotomy between the two elements of the research design. The next chapter describes the findings from the step-by-step elaboration of the components of Figure 27.

CHAPTER 4: RESEARCH FINDINGS

4.1 Introduction

The aim of this chapter is to report the findings of the present research as obtained using the methodology set out in Chapter 3. Here, the findings are presented in a logical sequence according to the structure presented in Figure 36. In this chapter are the research findings, encompassing quantitative and qualitative data, highlighted without bias or interpretation, the hypotheses merely being confirmed or rejected.

An interpretation of the findings is presented in Chapter 5 (Discussion of the quantitative findings) and in Chapter 6 (Discussion of the qualitative findings). The presentation of the research findings is therefore divided into two overarching categories: quantitative findings and qualitative findings. By separating the findings in this manner, the logical flow of the collection and an analysis of each category of the findings are maintained. The aim of this arrangement of the text is to communicate the amalgamated storyline emerging from the research findings in the most logical manner.

In the next quantitative section of this chapter, the findings from the collection of the quantitative data are briefly presented, followed by a presentation of the descriptive statistics of the quantitative findings by means of graphs, means, averages and other measures of central tendency. The objective here is to gain a general impression of what the data has to say (Howell, 2010, p. 5). Following these two sub-sections, a *K*-means cluster analysis concludes the presentation of the descriptive statistics. In the next sub-section of the chapter, the hypotheses relating to the relationship between the examined determinants[22] relevant to each of the four corners[23] of the diamond (see Section 2.4.2) and performance are tested and the regression equations are calculated, the latter with the objective of numerically expressing the relationship between the corner of the diamond and performance. Scatterplots, presenting the relationship between the estimated performance, as calculated with the help of the regression equations, and the actual performance, as provided by the sampled data, are computed to identify under-par, on-par and above-par performing universities in the sample used in the present research.

4.2 Quantitative Data Analysis

The objective of the quantitative data analysis draws on the research question, with the intention of explaining the impact of the determinants on university competitive advantage generated by research. The determinants of competitive advantage could be categorised into four broad categories of attributes: (1) *Factor conditions*; (2) *Demand conditions*; (3) *Related and supporting industries*; (4) *Firm strategy, structure and rivalry* (Porter, 1998, p. 71; see also Section 2.4.2 of this study).

4.2.1 Data Collection: Archival Data

The collection of the data draws on earlier research in UK higher education, examining an initial set of thirty-six departmental and institutional variables, this later being reduced to eight key variables (Curran, 2001, p. 223). Because many of the variables used in UK higher education had a unique UK origin or

[22] The *determinants* individual and as a system create the context in which competition takes place and include the resources and skills necessary for competitive advantage (Porter, 1998, p. 71).
[23] The *corners* of the diamond are the four broad attributes that shape the environment in which competition takes place and competitive advantage is created (Porter, 1998, p. 71).

were derived from HEFCE and RAE data, alternative derivations and sources were used in the present research. In total 15 determinants were analysed. These were selected on the basis of their closeness to each of the four broad categories of attributes and to the thirty-six departmental and institutional variables used in UK higher education. The main sources of the data were university websites and websites of institutions collecting and publishing quantitative data about German universities. Examples of the latter are the iFQ Institut für Forschungsinformation und Qualitätssicherung (Institute for research information and quality assurance) and the Statistisches Bundesamt (Federal statistical office). It was found that many of the 144 German universities failed to publish their annual report or any other form of statistical data on the Internet, and direct requests to the universities to provide the missing data remained unanswered. Depending of the nature of the data, from between 59 and 73 German universities could data points be included in the present study.

4.2.2 Descriptive Statistics

To set out in graphic form the distribution of the data concerning performance as well as the 15 analysed determinants, histograms were produced using SPSS software. These histograms are presented in Figures 37-52[24].

[24] Frequency refers to all outcomes between the upper and lower limits of the interval (Howell, 2010, p. 19).

Figure 34: Absolute performance.

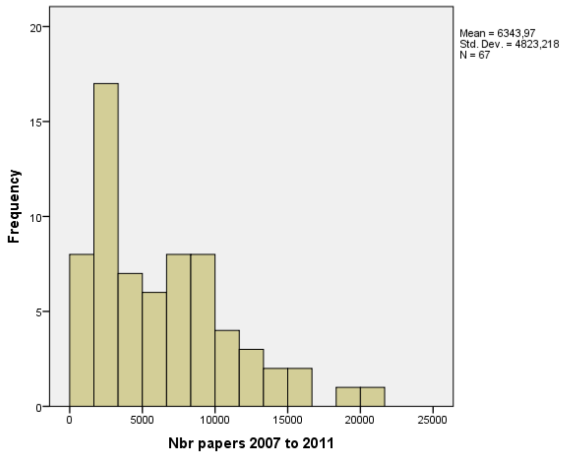


Figure 35: Total income

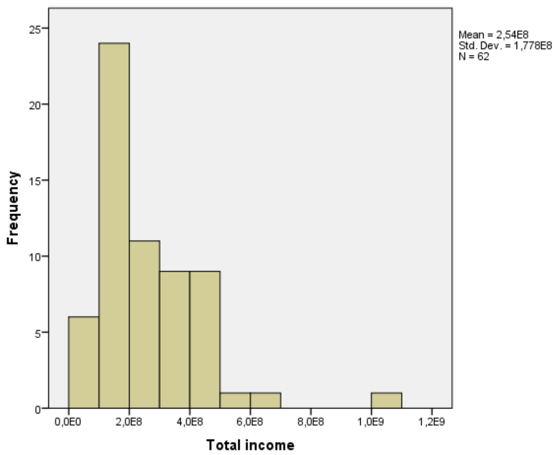


Figure 36: Teaching funding.

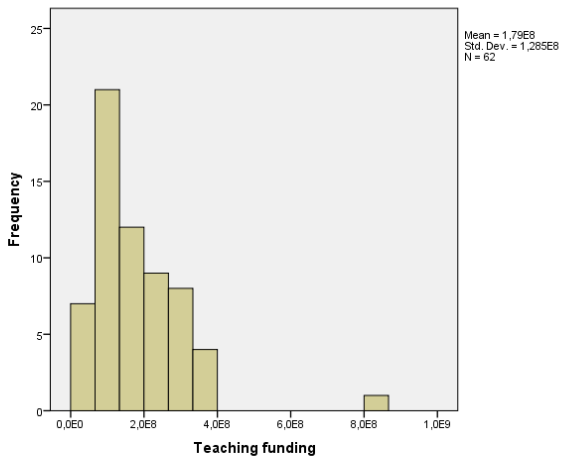


Figure 37: Research funding

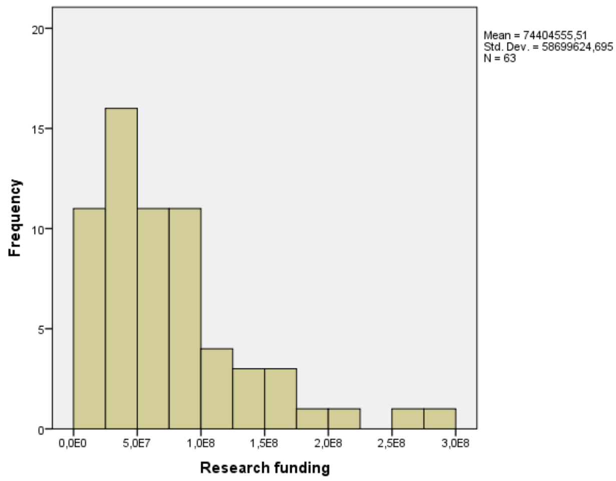


Figure 38:Total library expenditure

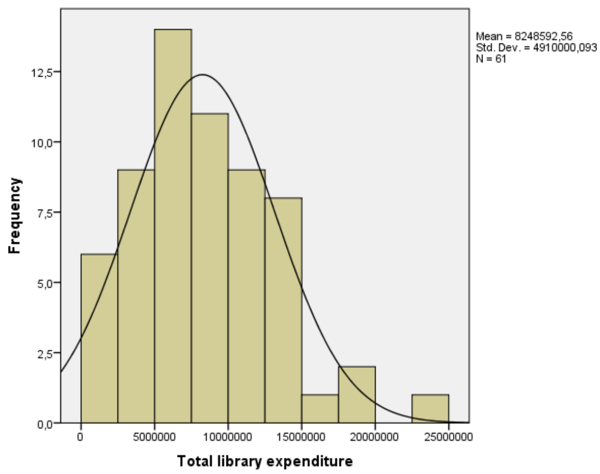


Figure 39: Ratio papers to staff.

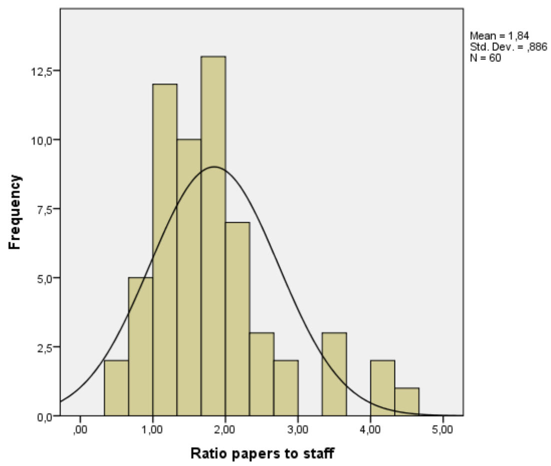


Figure 40: Ratio papers to academic staff

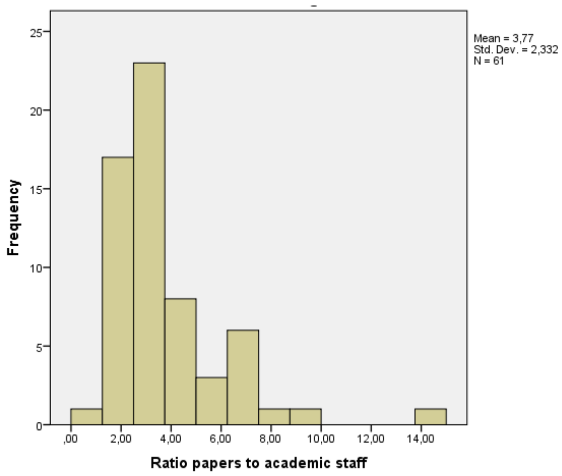


Figure 43: Ratio of non-academic staff to academic staff

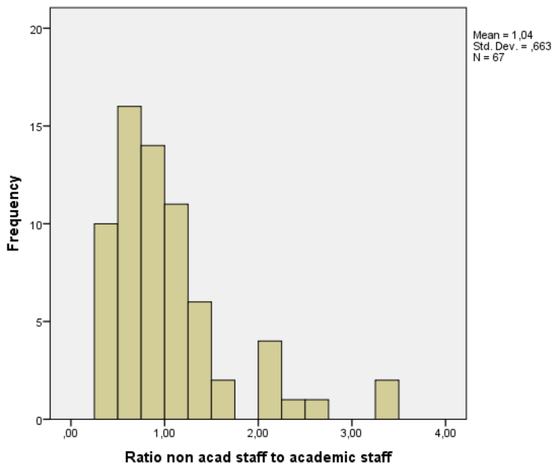


Figure 41: Ratio research income to staff (x 10K)

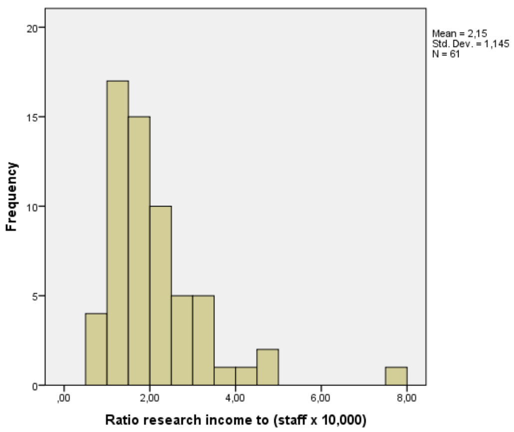


Figure 44: Academic staff

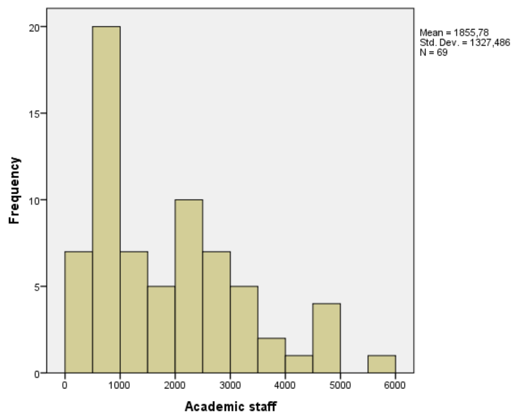


Figure 42: Ratio total income to staff (x10K)

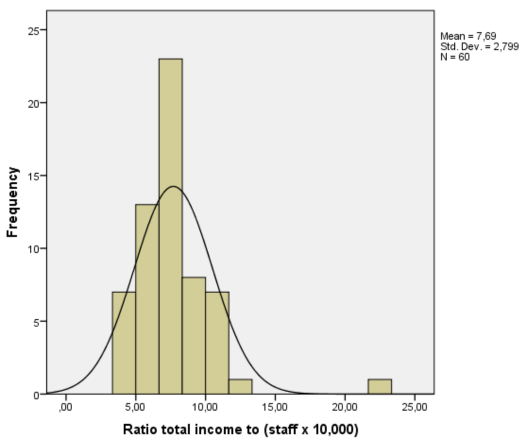


Figure 45: SciVal subject areas

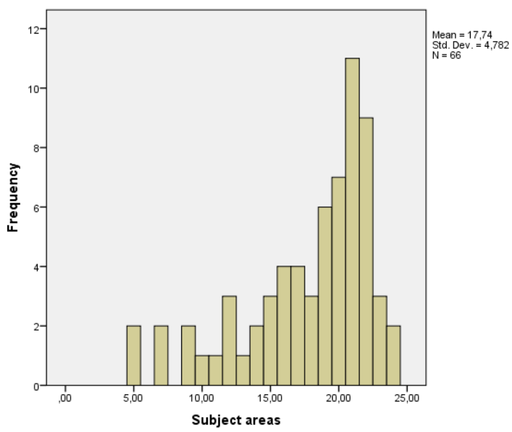


Figure 46: Total authors in Scopus

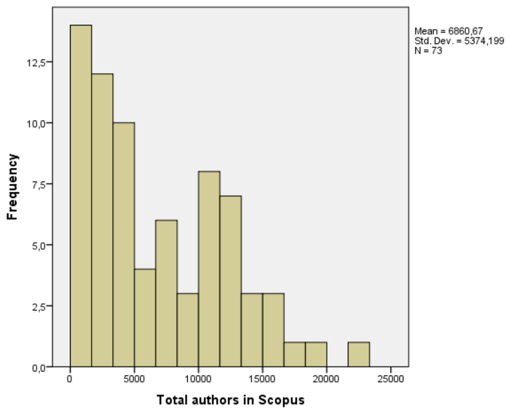


Figure 48: Total non-academic staff

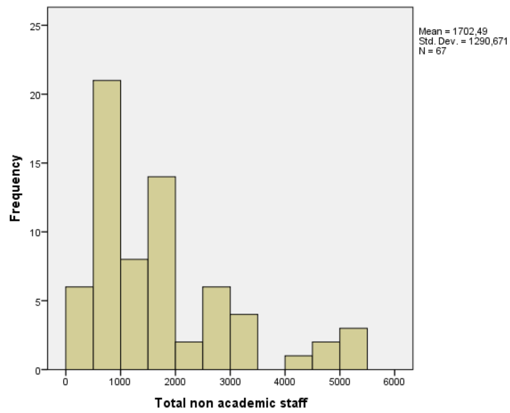


Figure 47: All staff

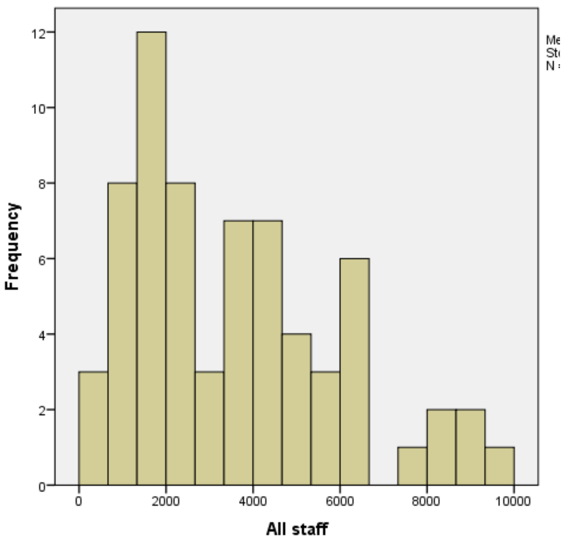
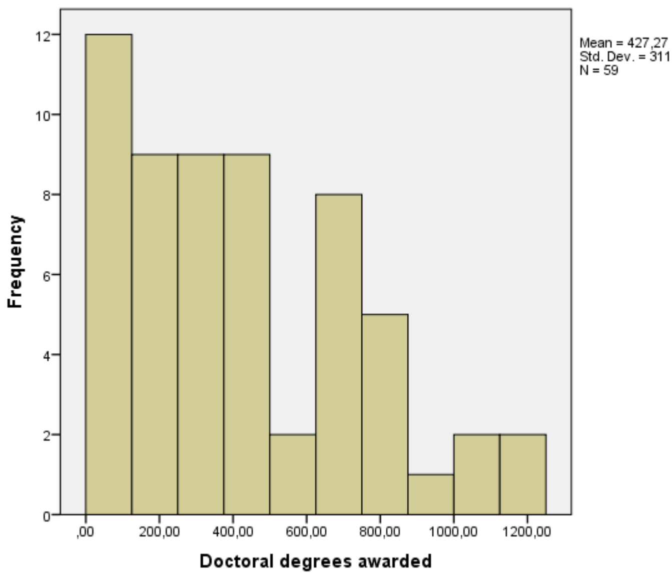


Figure 49: Total Doctoral Degrees awarded



As shown in Figure 37, the distribution of the *Absolute performance* scores demonstrated an asymmetric distribution with a tail inclining to the right (= this being positively skewed). There are statistical measures concerning the degree of asymmetry but these are rarely used in social sciences (Howell, 2010, p.27) and therefore not provided here. A positively skewed distribution points to the absolute performance being inversely proportionate to the number of universities in the sample, with most universities in the sample showing low performance. A visual inspection of the histogram also showed multiple modes.

When making a visual comparison with Figure 37 showing *Absolute performance*, Figure 38 for *Total income*, Figure 39 for *Teaching funding* and Figure 40 for *Research funding* show similar distributions. Here, noteworthy is the distribution of the scores for *Teaching income* being more akin to the distribution of the scores for *Total income* than to the distribution of the scores for *Research income*. Whereas Figures 37-40 showed positively skewed curves, showed the distribution of scores of the *Total library expenditure* in Figure 41 an almost normal distribution, centred around the interval of €7.5-10M. Here, *Total library expenditure* is used as an indicator of the investment in scholarship (Curran, 2001, p. 228). To indicate the nearness of the frequency distribution in Figure 41 to a *normal* distribution, the *normal* curve was superimposed on Figure 41. The universities with the highest annual library expenditure are the University of Bremen, the University Frankfurt, the University Gottingen and the University of Hamburg, these however not being the largest universities in the sample. This finding suggests that investment in scholarship is governed by other considerations beyond funding.

Figure 42 for the *Ratio of papers to staff* also indicated an almost normal distribution, this centred around a *Ratio of papers to staff* of 2 (for a five years period) with a heightened presence in the lower values. Here, the outliers (Ratio > 3) are the University of Frankfurt, the University of Freiburg, the Technical University in Hamburg, the University of Leipzig, the Ludwig Maximilian University of Munich and the University of Ulm, these all publishing most papers per staff. Figure 42 is very similar to Figure 45 for the *Ratio of the total income to staff* and shows an almost *normal* distribution, this being centred around a *Ratio total income to all staff* of € 75,000 with an increased presence in the lower values and one outlier: the Technical University of Hamburg. The similarity between Figure 42 and 45 suggest a relationship between the ability of staff members to publish their research output and generate income.

Comparable similarities were found between Figure 43 for the *Ratio of papers to academic staff* and Figure 44 for the *Ratio of research income to staff*. Both histograms showed a positively skewed distribution of scores, this indicating that the ability to publish research outcome and to generate research income is inversely proportionate to the number of universities in the sample; only a few universities in the sample published a very large amount of material and generated the highest income. The outlier in Figure 43 was the University of Freiburg, while the outlier in Figure 44 was the University of Hamburg.

The distribution of the scores in Figure 46 for the *Ratio of non-academic staff to academic staff* clearly showed multiple modes, pointing to three groups of universities. Here, the outlier was the Technical University of Dresden. A similar distribution of three groups of universities was shown in Figure 47 for *Academic staff.* The outliers included the RWTH Aachen, the University of Bonn, the University of Erlangen-Nurnberg, KIT Karlsruhe, the Technical University of Munich, the University of Munster, the University of the Saarland and the University of Tubingen.

Figure 48 for *SciVal subject areas* was the only histogram showing a negatively skewed distribution, indicating that being present in more research areas is proportionate to the number of universities in the sample - most universities in the sample were active in a broad spectrum of research areas.

When comparing Figure 49 for the *Total authors* and Figure 50 for *All staff*, there were similarly positively skewed distributions. However, compared with these two histograms, Figure 51 for *Total non-academic staff* had a much stronger positively skewed distribution, an indication that the inverse proportionality was stronger, and the number of universities with relatively more non-academic staff was rapidly declining.

Figure 52 for the *Doctoral degrees awarded* also showed a positively skewed distribution, but this was much softer, an indication that the inverse proportionality was much weaker.

The minimum, maximum, mean, mode and standard deviation and coefficient of variation of the 16 variables analysed are presented in Table 19.

Table 19: Measures of central tendency

	Variable	N=	Min.	Max.	Mean	Mode	Standard deviation	Coefficient of variation
1	Number of papers published 2007 to 2011	67	522	21.141	6.344	522 *	4.823	76%
2	Total income	62	18.900.000	1.095.000.000	254.166.542	18,900,000 *	177.752.437	70%
3	Teaching income	62	16.800.000	836.200.000	179.261.026	16,800,000 .	128.508.880	72%
4	Research income	63	2.100.000	280.509.066	74.404.556	2,100,000 *	58.699.625	79%
5	Total library expenditure	61	280.961	24.142.746	8.248.593	280,961 *	4.910.000	60%
6	Ratio papers (2007-2011) to all staff	60	0,4	4,5	1,8	0.38 *	0,9	48%
7	Ratio papers (2007-2011) to academic staff	61	1,1	14,8	3,8	1.10 *	2,3	62%
8	Ratio research income to all staff.	61	7.000,0	75.100,0	21.500,0	7,000 *	11.500,0	53%
9	Ratio total income to all staff.	60	36.300,0	217.400,0	76.911,0	36,300 *	27.990,4	36%
10	Ratio nonacademic staff to academic staff.	67	0,3	3,5	1,0	0.31 *	0,7	64%
11	Total academic staff	69	308	5.809	1.856	308 *	1.327	72%
12	SciVal subject areas	66	5	24	18	21	5	27%
13	Total number of authors	73	416	21.846	6.861	416 *	5.374	78%
14	Total number of staff	67	548	9.425	3.600	6.152	2.366	66%
15	Total number of nonacademic staff	67	209	5.230	1.702	209 *	1.291	76%
16	Total number of doctoral degrees awarded	59	40	1.205	427	687	311	73%

* multiple modes exist.

The data provided in Table 19 indicated that the *average* university in the sample had a total income of €254M, of which €179M (70%) was for the teaching income and €74M (29%) for research income; €8.2M (3%) was spent on its library. The total income/funding per staff member (academic and non-academic) was €76,911, of which €21,500 (28%) was research income. On average per university, 427 doctoral degrees were awarded annually. The data in Table 19 also indicated that the *average* university published about 1 paper every 3 years (=1.8/5) per staff member (academic and non-academic) and < 1 (3.8/5=0.75) paper per year per academic staff member. The *average* university in the sample had competencies in 18 subject areas on average. The total number of authors per university contributing over the years to the advancement of knowledge is 6,861. Table 19 also indicates that the *average* number of staff (academic and non-academic) per university in the sample is 3,600 of which 1,702 (47%) represents non-academic staff, and 1856 (52%) academic staff - a ratio of non-academic staff to academic staff of about 1.

The *coefficient of variation* of the values in table 19 made it possible to compare the very different means of the variables included in the table. The objective of calculating the *coefficients of variation* came from the desire to study the differences between the universities in the sample and here larger standard deviations provided an indication of sufficient variability (Howell, 2010, pp. 44-45). As the large *coefficients of variation* in the table were the result of variance in the archival data and not attributable to sloppy measurements, they suggest that there was enough variability.

4.2.3 *K*-means cluster analysis

With the exception of the variables S*ciVal subject areas,* the *Number of all staff* and the *Doctoral degrees awarded,* Table 19 shows that all the variables analysed had frequency distributions with multiple modes, this suggesting that the universities in the sample belonged to different clusters. With the help of SPSS, a *K*-means cluster analysis was performed to partition the universities in the sample into clusters, so that each university belonged to the cluster with the nearest mean.

The ANOVA[25] data in Table 20 indicates which variables contributed most to the cluster solution. Here, the greatest separation between the clusters was provided by the 5 institutional variables with the largest *F* values[26], these being: (1) *Total income*; (2) *Teaching funding*; (3) *Research funding*; (4) *Total authors*; and (5) T*otal staff,* and suggesting that all the clustering of the universities in the sample is based on the size of the universities.

[25] ANOVA = Analysis of Variance (Acton and Miller, 2009, p. 347).

[26] The F-ratio is arrived at by comparing the variance between groups with the variance within groups (Acton and Miller, 2009, p.184).

Table 20: The ANOVA table for 15 variables examined according to their relationship to performance

	Cluster		Error			
	Mean Square	df	Mean Square	df	F	Sig.
Allincome Total income	5,841E+17	3	3,016E+15	58	193,703	,000
Tfunding Teaching funding	3,027E+17	3	1,709E+15	58	177,105	,000
Rfunding Research funding	4,863E+16	3	1,148E+15	59	42,356	,000
TotLibexp Total library expenditure	1,392E+14	3	1,805E+13	57	7,714	,000
Rpaptostaff Ratio papers to staff	,345	3	,808	56	,427	,735
Rpaptoacadstaff Ratio papers to academic staff	2,158	3	5,612	57	,384	,765
Rrinctostaff Ratio research income to (staff x 10,000)	,298	3	1,365	57	,218	,883
Rtotinctostaff Ratio total income to (staff x 10,000)	6,478	3	7,907	56	,819	,489
Rnonacadtoacad Ratio non acad staff to academic staff	1,349	3	,396	63	3,409	,023
acadstaff Academic staff	17851762,67	3	1019625,503	65	17,508	,000
subjareas Subject areas	165,698	3	15,960	62	10,382	,000
Authors Authors	366843476,0	3	14188040,70	69	25,856	,000
Allstaff All staff	65350112,65	3	2752190,960	63	23,745	,000
Nonacadstaff Total non academic staff	18428306,11	3	867617,245	63	21,240	,000
Totdoc Doctoral degrees awarded	712542,962	3	63186,232	55	11,277	,000

The final cluster centres for the 3 clusters computed as the mean for each variable within each final cluster are provided in Table 21.

Table 21: Final cluster centres of the three clusters of universities within the sample of German universities

	Cluster			
	1	2	3	4
Allincome Total income	488183970	130976906	339641153	1095000000
Tfunding Teaching funding	329889833	93982188	238668021	836200000
Rfunding Research funding	158294137	37176155	100973131	258800000
TotLibexp Total library expenditure	12538026	6049712	10577891	10936881
Rpaptostaff Ratio papers to staff	1,82	1,74	2,02	2,09
Rpaptoacadstaff Ratio papers to academic staff	4,54	3,52	3,95	4,20
Rrinctostaff Ratio research income to (staff x 10,000)	2,24	2,06	2,24	2,78
Rtotinctostaff Ratio total income to (staff x 10,000)	7,11	7,76	7,58	11,77
Rnonacadtoacad Ratio non acad staff to academic staff	1,66	1,02	,83	,84
acadstaff Academic staff	2808	1094	2780	3670
subjareas Subject areas	22,17	15,51	20,45	24,00
Authors Authors	13328	3737	10207	14685
Allstaff All staff	6471	2143	4816	6916
Nonacadstaff Total non academic staff	3664	1014	2037	3247
Totdoc Doctoral degrees awarded	800,14	256,43	539,15	566,00

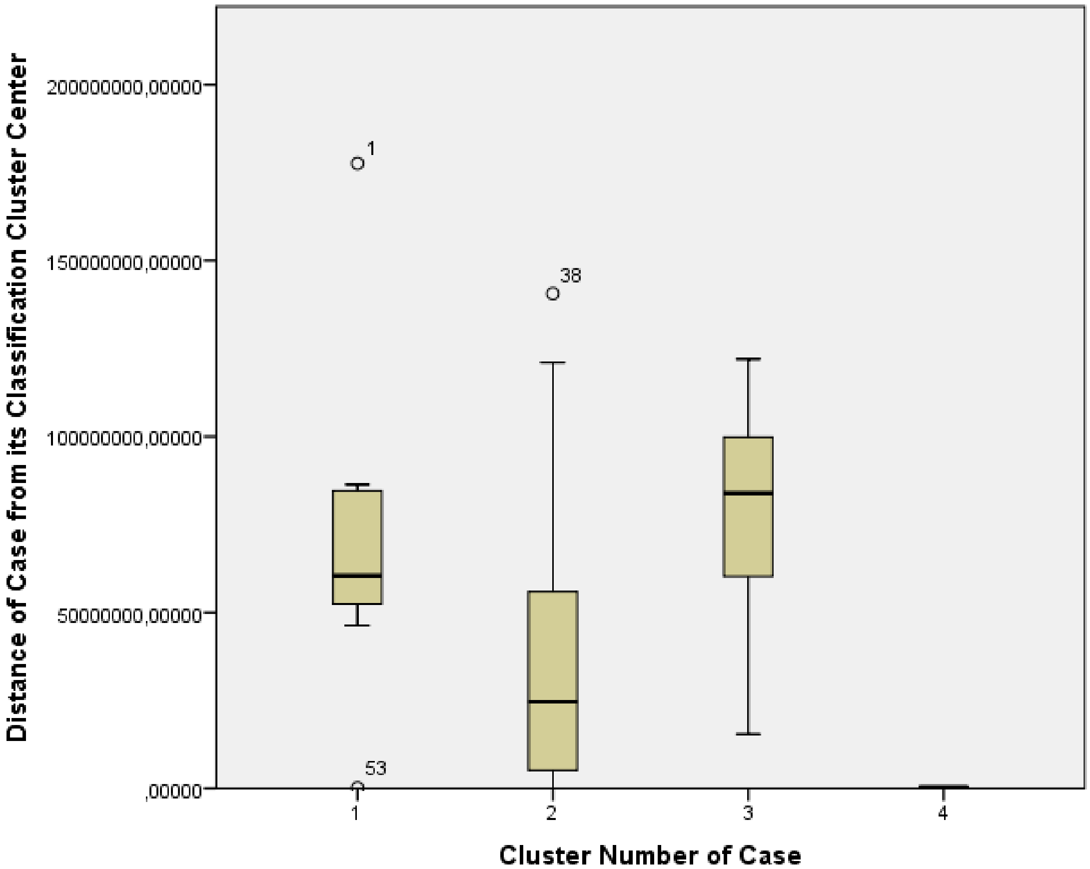
A total of 77 universities in the sample were thus segmented into 4 clusters. The number of universities in each cluster and the mean total income are presented in Table 22.

Table 22: Number of universities in each cluster

	Number of universities in cluster	**Mean total income (in €)**
Cluster 1	8	488,183,970
Cluster 2	48	130,976,906
Cluster 3	20	339,641,153
Cluster 4	1	1,095,000,000

The boxplot in Figure 53 shows the median, range and the quartiles as well as any outliers in graphical format.

Figure 50: Boxplot of the 4 clusters



The outliers in Figure 53 are RWTH Aachen (#1) and the University of Halle-Wittenberg (#53) in Cluster 1 with the University of Flensburg (#38) in Cluster 2.

The 8 universities in Cluster 1 are given in Table 23.

Table 23: The Universities in Cluster 1 (mean Total income = €488 M)

Number	Name	Cluster number
1	Aachen (HS) Rheinisch-Westfälische Technische Hochschule Aachen	1
12	Berlin (U) Technische Universität Berlin	1
16	Bonn (U) Rheinische Friedrich-Wilhelms-Universität Bonn	1
29	Dresden (U) Technische Universität Dresden	1
50	Göttingen (U) Georg-August-Universität Göttingen	1
53	Halle (U) Martin-Luther-Universität Halle-Wittenberg	1

60	Hamburg (U) Universität Hamburg	1
99	München (U) Ludwig-Maximilians-Universität München	1

The 48 universities in Cluster 2 are given in Table 24.

Table 24: The Universities in Cluster 2 (mean Total income = €131 M)

Number	**Name**	**Cluster number**
3	Augsburg (U) Universität Augsburg	2
4	Bamberg (U) Otto-Friedrich-Universität Bamberg	2
5	Bayreuth (U) Universität Bayreuth	2
14	Bielefeld (U) Universität Bielefeld	2
19	Bremen (U) Jacobs University Bremen	2
21	Chemnitz (U) Technische Universität Chemnitz	2
22	Clausthal-Zellerfeld (U) Technische Universität Clausthal	2
23	Cottbus (U) Brandenburgische Technische Universität Cottbus	2
25	Detmold (KHS) Hochschule für Musik Detmold	2
34	Erfurt (U) Universität Erfurt	2
38	Flensburg (U) Universität Flensburg	2
43	Freiberg (U) Technische Universität Bergakademie Freiberg	2
49	Gießen (U) Justus-Liebig-Universität Gießen	2
51	Greifswald (U) Ernst-Moritz-Arndt-Universität Greifswald	2
56	Hamburg (U) Helmut-Schmidt-Universität/Universität der Bundeswehr Hamburg	2
59	Hamburg (U) Technische Universität Hamburg-Harburg	2
62	Hannover (KHS) Hochschule für Musik, Theater und Medien Hannover	2
64	Hannover (HS) Stiftung Tierärztliche Hochschule Hannover	2
67	Ilmenau (U) Technische Universität Ilmenau	2
68	Jena (U) Friedrich-Schiller-Universität Jena	2
69	Kaiserslautern (U) Technische Universität Kaiserslautern	2
74	Kassel (U) Universität Kassel	2
75	Kiel (U) Christian-Albrechts-Universität zu Kiel	2
77	Köln (HS) Deutsche Sporthochschule Köln	2
81	Konstanz (U) Universität Konstanz	2
85	Leipzig (U) Universität Leipzig	2
87	Lübeck (U) Universität zu Lübeck	2
89	Lüneburg (U) Leuphana Universität Lüneburg	2
90	Magdeburg (U) Otto-von-Guericke-Universität Magdeburg	2
91	Mainz (U) Johannes Gutenberg-Universität Mainz	2
92	Mainz (U) Universität Koblenz-Landau	2

94	Mannheim (U) Universität Mannheim	2
103	Neubiberg (U) Universität der Bundeswehr München	2
106	Oldenburg (U) Carl von Ossietzky Universität Oldenburg	2
107	Osnabrück (U) Universität Osnabrück	2
109	Paderborn (U) Universität Paderborn	2
110	Passau (U) Universität Passau	2
112	Potsdam (U) Universität Potsdam	2
113	Regensburg (U) Universität Regensburg	2
115	Rostock (U) Universität Rostock	2
119	Siegen (U) Universität Siegen	2
123	Stuttgart (U) Universität Hohenheim	2
126	Trier (U) Universität Trier	2
128	Tübingen (U) Eberhard-Karls-Universität Tübingen	2
129	Ulm (U) Universität Ulm	2
133	Weimar (HS) Bauhaus-Universität Weimar	2
137	Witten (U) Private Universität Witten/Herdecke gGmbH	2
138	Wuppertal (U) Bergische Universität Wuppertal	2

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The 20 universities in Cluster 3 are provided in Table 25.

Table 25: The Universities in Cluster 3 (mean Total income = €340 M)

Number	**Name**	**Cluster number**
8	Berlin (U) Freie Universität Berlin	3
9	Berlin (U) Humboldt-Universität zu Berlin	3
15	Bochum (U) Ruhr-Universität Bochum	3
18	Braunschweig (U) Technische Universität Carolo-Wilhelmina zu Braunschweig	3
20	Bremen (U) Universität Bremen	3
24	Darmstadt (U) Technische Universität Darmstadt	3
26	Dortmund (U) Technische Universität Dortmund	3
30	Düsseldorf (U) Heinrich-Heine-Universität Düsseldorf	3
35	Erlangen (U) Friedrich-Alexander-Universität Erlangen-Nürnberg	3
37	Essen (U) Universität Duisburg-Essen	3
41	Frankfurt (U) Johann Wolfgang Goethe-Universität, Frankfurt am Main	3
44	Freiburg (U) Albert-Ludwigs-Universität Freiburg im Breisgau	3
61	Hannover (U) Gottfried Wilhelm Leibniz Universität Hannover	3
66	Heidelberg (U) Ruprecht-Karls-Universität Heidelberg	3
71	Karlsruhe (U) Karlsruher Institut für Technologie	3
80	Köln (U) Universität zu Köln	3

102	Münster (U) Westfälische Wilhelms-Universität Münster	3
116	Saarbrücken (U) Universität des Saarlandes	3
124	Stuttgart (U) Universität Stuttgart	3
141	Würzburg (U) Julius-Maximilians-Universität Würzburg	3

The university in Cluster 4 is given in Table 26.

Table 26: The University in Cluster 4 (mean Total income = €1.095 M)

Number	**Name**	**Cluster number**
100	München (U) Technische Universität München	4

The relationship between 15 indicators and competitive advantage generated by research is analysed via Single Linear Regression Analysis using SPSS and presented in Table 27.

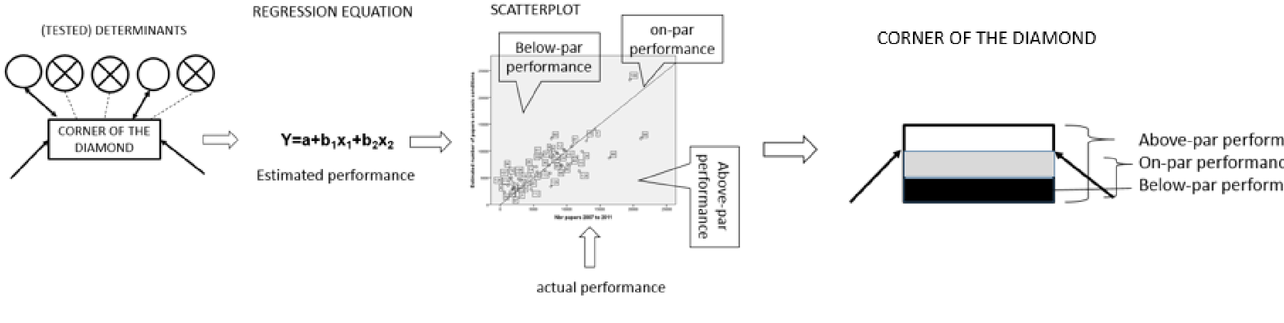
Table 27: Indicators and their relationship with research performance

	Independent variable	**N=**	**R**	**R Square**	**F**	**Sig.**
1	Total income	54	0.783	0.613	84.011	0.000
2	Total teaching funding	54	0.729	0.532	60.180	0.000
3	Total teaching funding	54	0.729	0.532	60.180	0.000
4	Total library expenditure	52	0.485	0.235	15.667	0.000
5	Ratio of papers to all staff	59	0.438	0.192	13.775	0.000
6	Ratio of papers to academic staff	60	0.359	0.129	8.723	0.005
7	Ratio of research income to all staff	55	0.045	0,002	0.109	0.743
8	Ratio of total income to all staff	54	0.184	0.034	1.867	0.178
9	Ratio of non-academic staff to academic staff	59	0.022	0.000	0.029	0.866
10	Number of academic staff	61	0.773	0.598	89.261	0.000
11	Number of SciVal subject areas	66	0.695	0.483	60.751	0.000
12	Number of authors	66	0.939	0.881	480.622	0.000
13	Number of university staff	59	0.828	0.686	126.936	0.000
14	Number of non-academic university staff	59	0.729	0.531	65.592	0.000
15	Number of doctoral degrees awarded	51	0.790	0.624	83.530	0.000

4.2.4 Inferential Statistics: Hypothesis testing using Multivariate Linear Regression Analysis (MLRA) and Scatterplots

To explore the extent to which each of the tested independent *x* variables (= the determinants of each corner of the diamond) are important for predicting the most likely value of the dependent *y* variable (= the condition of each corner in Porter's diamond; see Section 2.4.1), four step-wise multi-regression analyses were performed with help of SPSS. The outcomes of the analyses were presented in the format of four multiple regression equations: $y = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots + b_nx_n$, each including all the independent *x* variables that had a significant effect upon the dependent *y* variable. Independent variables with no significant effect on the dependent variable were excluded in the course of the analysis. After this, scatterplots were computed using SPSS and the *estimated* performances, as calculated with the regression equations, were plotted against the actual performances with the objective of identifying under-par, on-par, and above-par performing universities. Here, combining the conditions of all four corners of the diamond of a university in the sample provided the condition of the whole diamond for that university. The latter was indicative of the stage in the process of development of competitive advantage generated by research of any given university (see Section 2.4.1). The process of establishing the condition for each corner of the diamond is depicted in Figure 54.

Figure 51: The process of establishing the condition for each corner of the diamond



The first step in the establishment of the condition of a diamond corner was to test the extent to which each of the tested determinants played a part in predicting what the most likely condition of the related corner of the diamond would be. For this purpose, four Null Hypotheses were formulated, each testing the relationship between the tested determinants and the condition of one of the four corners of the diamond.

In recognition of the differences between the cultures in the higher education sector and the corporate sector, these revealing themselves in the vocabulary used (see Section 2.4.3), the names of the corners of the diamond were adapted to the language of the higher education sector: *Factor conditions* was designated as *Basic conditions to compete*; *Firm strategy, structure and rivalry* was renamed *Strategy, structure and rivalry conditions to compete*; *Demand conditions* was labelled *Ability related conditions to* compete; *Related and supporting industries* was classed as *Collaborator and role model conditions to compete*.

The first Null Hypothesis tested was as follows: *There is no statistical significant relationship between the determinants of the corner Basic conditions to compete* and *performance*. Here, four independent variables representing the *Basic conditions to compete* were entered in the analyses: (1) *Total income*; (2) *Total teaching funding*; (3) *Total research funding*; (4) *Total library expenditure*. Two variables were excluded in the course of the analysis because their coefficient became non-significant due to the effects of the other independent variables: (1) *Total teaching funding*; (2) *Total research funding*.

Table 28: Model Summary for the MLRA.

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	,797[a]	,635	,627	2899,995	,635	76,564	1	44	,000	
2	,817[b]	,667	,651	2802,799	,032	4,105	1	43	,049	2,306

a. Predictors: (Constant), Allincomex10mio All income x 10 million

b. Predictors: (Constant), Allincomex10mio All income x 10 million, TotLibExpxmio Total library expenditure x million

c. Dependent Variable: Allpapers Nbr papers 2007 to 2011

A comparison of the *R Squares* in Table 28 shows that the amount of explained variance had slightly improved in the course of the MLR analysis, this being from 63,5% to 66.7%. Table 28 further indicates that the *Durbin-Watson* statistic = 2.306 (> 1), an indication that the overlap between the constituting independent variables (*multicollinearity*) was not too large.

Table 29: Analysis of Variance (ANOVA) of the final step in the MLRA of the Basic conditions to compete.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	643900348,4	1	643900348,4	76,564	,000[b]
	Residual	370038685,9	44	8409970,135		
	Total	1013939034	45			
2	Regression	676144666,3	2	338072333,2	43,035	,000[c]
	Residual	337794368,1	43	7855682,978		
	Total	1013939034	45			

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

b. Predictors: (Constant), Allincomex10mio All income x 10 million

c. Predictors: (Constant), Allincomex10mio All income x 10 million, TotLibExpxmio Total library expenditure x million

In Table 29 it can be seen that the regression statistic of the second step in the analysis F= 43.035 (F>>0), this indicating that the results did not occur by chance. Here, the value of Sig. = 0.000 makes clear that a highly significant amount of variance in the dependent variable could be explained.

Table 30: Coefficients box of the MLRA of the Basic conditions to compete.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1562,848	780,304		2,003	,051		
	Allincomex10mio All income x 10 million	205,745	23,513	,797	8,750	,000	1,000	1,000
2	(Constant)	78,044	1051,600		,074	,941		
	Allincomex10mio All income x 10 million	191,544	23,782	,742	8,054	,000	,913	1,095
	TotLibExpxmio Total library expenditure x million	209,177	103,248	,187	2,026	,049	,913	1,095

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

Table 30 shows for the resulting solution, the unstandardized B coefficient= 78.044 . This is the amount of change in *y* by a change of one unit *x* (= slope of the regression line). Table 30 also indicates the Collinearity Statistics: the *Tolerances* were all >0.4 and VIF were all <10, indicating that the values were within acceptable margins.

Therefore, the Null hypothesis - *There is no statistical significant relationship between the determinants of the corner Basic conditions to compete* and *performance* - was shown to be false and the conclusion that the concept of *Basic conditions to compete* influences the research performance was accepted.

The *Multiple Regression Equation* emerging from the step-wise MLR analysis of the independent variables and representing the *Basic conditions to compete* corner of Porter's diamond model is given in Table 31.

Table 31: Multiple Regression Equation for the dependent variable based on the Basic conditions to compete

Number of papers 2007 – 2011 = 78.044 + 191.544 (*All income* x ten million) + 209.177 (*Total library expenditure* x million)

Not every calculated value of the dependent variables of the universities in the sample using the *Multiple Regression Equation* in Table 31 correspond exactly to the collected values. The differences between the calculated and the collected values, the *Residual Differences,* were diagnosed case by case, to locate any individual case that diverged widely from the calculated value. Table 25 shows the *Case-wise diagnostics* table, including the case in which the actual value varied widely from the value the equation predicts.

Table 32: Case-wise diagnostics.

Casewise Diagnostics[a]

Case Number	Std. Residual	Allpapers Nbr papers 2007 to 2011	Predicted Value	Residual
99	3,138	21141	12344,67	8796,331

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

The case-wise diagnostics box in Table 32 shows that there was one case - #99 - where the actual value for the performance varied widely from the value the *Multiple Regression Equation* predicted. However, based on the source of the data, this was most likely a legitimate case and was therefore not removed from the analysis.

Figure 52: Histogram of residuals

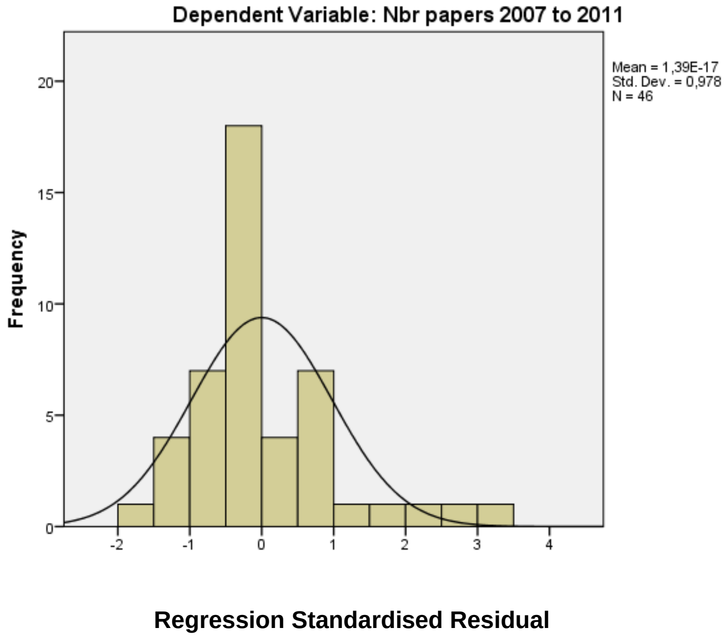


Figure 55 shows that the distribution of residual values was neither a *normal* distribution nor centred around zero. The bulk of the residuals were negative with a very pronounced group between zero and -0.5. A comparison of the frequency distribution in Figure 55 with Figure 37 showed for both a deviation from a *normal* distribution and an over-estimation in the lower values.

Figure 53: Normal P-P plot of regression standardised residual

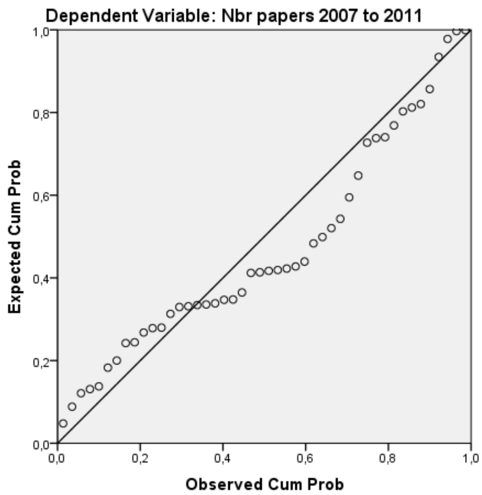


Figure 56 indicates that the plot of the expected versus the actual values diverges/converges from the straight 45-degree line. The equation over-estimated the lower values and under-estimated the middle values, resulting in an s-shaped curve (*Heterogeneity of variance* or *Heterocedasticity*).

Figure 57 shows the plot of the actual and estimated (=calculated) performances. Universities in the sample with an actual higher performance than what was calculated with the *Multiple Regression Equation* in Table 31 are found in the triangle below the X/Y-axes in the figure, and universities in the sample with an actual lower performance than estimated are found in the triangle above the X/Y axes in the figure.

Figure 54: Scatterplot[27] of the actual and estimated Number of papers from 2007 to 2011 according to their Basic condition to compete.

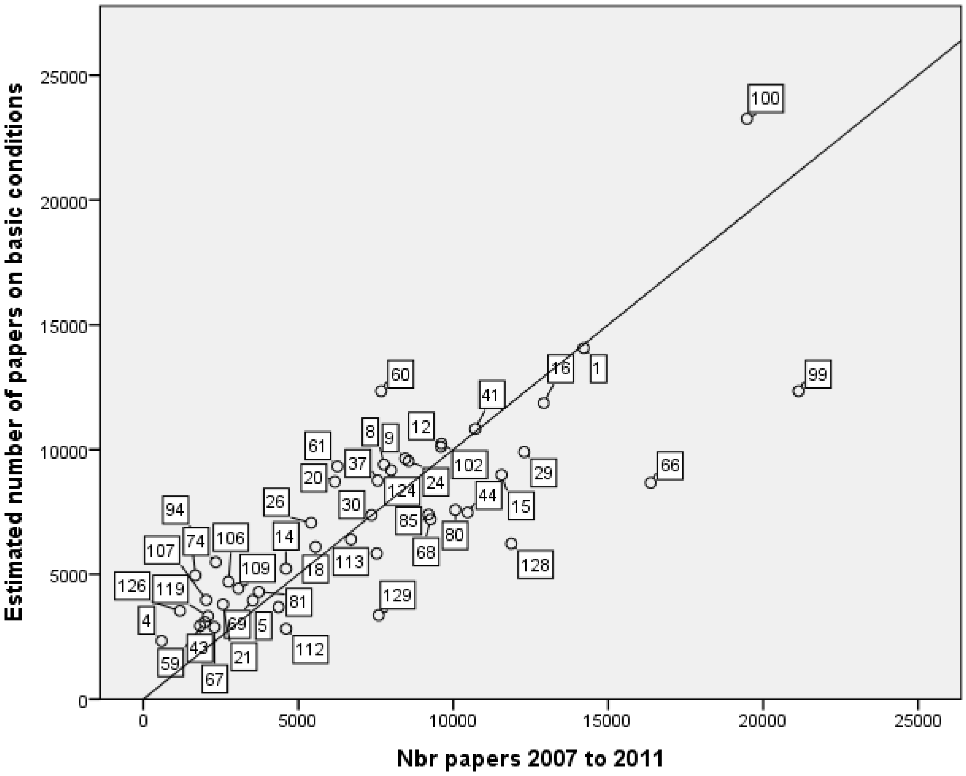


Figure 57 depicts the condition of the corner *Basic conditions to compete* for each university in the sample. The approximate position of the universities, whether under-par, on-par or above-par performing on the *Basic conditions to compete* corner of Porter's diamond, contribute to the identification of the stage of competitive development of each university in the sample. The identification of the stage of competitiveness generated by research for each university is further elaborated in Section 4.3 of this chapter.

[27] The numbers in the scatterplot correspond with the numbers of the universities included in the Tables 22-25.

The second Null Hypothesis tested was as follows: *There is no statistical significant relationship between the determinants of the corner Ability related conditions to compete and performance*. A total of five independent variables representing the *Ability related conditions to compete* were entered in the analyses, these being: (1) the *Ratio of papers to all staff*; (2) the *Ratio of papers to academic staff*; (3) the *Ratio of research income to all staff;* (4) the *Ratio total income to all staff*; (5) the *Ratio of non-academic staff to academic staff*.

The following three variables were removed in the course of the analysis since their coefficient became non-significant due to the effects of the other independent variables: (1) the *Ratio papers to academic staff*; (2) the *Ratio of research income to all staff* (3) *the Ratio of non-academic staff to academic staff*.

Table 33: Model Summary for the MLR analysis of the determinants of the Ability related conditions to compete

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	,371[a]	,137	,121	4530,971	,137	8,442	1	53	,005	
2	,524[b]	,275	,247	4193,982	,137	9,859	1	52	,003	1,747

a. Predictors: (Constant), Rpaptostaff Ratio papers to staff

b. Predictors: (Constant), Rpaptostaff Ratio papers to staff, Rtotinctostaff Ratio total income to (staff x 10,000)

c. Dependent Variable: Allpapers Nbr papers 2007 to 2011

A comparison of the *R Squares* in Table 33 showed that the amount of explained variance had improved in the course of the MLR analysis from 13.7% to 27.5%. Table 33 further demonstrated that the *Durbin-Watson* statistic = 1.747 (> 1), an indication that the overlap between the constituting independent variables (*multicollinearity*) was not too large.

Table 34: Analysis of Variance (ANOVA) for the final step in the MLR analysis of the Ability related conditions to compete

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	173315860,4	1	173315860,4	8,442	,005[b]
	Residual	1088073779	53	20529693,95		
	Total	1261389640	54			
2	Regression	346736535,8	2	173368267,9	9,856	,000[c]
	Residual	914653103,9	52	17589482,77		
	Total	1261389640	54			

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

b. Predictors: (Constant), Rpaptostaff Ratio papers to staff

c. Predictors: (Constant), Rpaptostaff Ratio papers to staff, Rtotinctostaff Ratio total income to (staff x 10,000)

Table 34 shows the regression statistic F= 9.856 (F>0) indicating that the results did not occur by chance. The value of Sig. = 0.000 explained that a highly significant amount of variance in the dependent variable could be explained.

Table 35: Final solution in the Coefficients box of the MLR analysis of the Ability related conditions to compete

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3145,125	1525,170		2,062	,044		
	Rpaptostaff Ratio papers to staff	2092,620	720,216	,371	2,906	,005	1,000	1,000
2	(Constant)	6577,869	1785,548		3,684	,001		
	Rpaptostaff Ratio papers to staff	3042,590	732,089	,539	4,156	,000	,829	1,206
	Rtotinctostaff Ratio total income to (staff x 10,000)	-686,444	218,616	-,407	-3,140	,003	,829	1,206

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

Table 35 made clear the unstandardized B coefficient= 6,577.869. This is the amount of change in *y* by a change of one unit *x* (= slope of the regression line). Table 35 further showed the Collinearity Statistics: the *Tolerances* were all >0.4 and *VIF* were all <10, indicating that the values are within acceptable margins.

Therefore the null hypothesis that: *There is no statistical significant relationship between the determinants of the corner Ability related conditions to compete* *and performance* was false and the conclusion that the *Ability related conditions to compete* influenced the research performance was accepted.

The *Multiple Regression Equation* that emerged from the step-wise MLR analysis of the independent variables representing the *Ability related conditions to compete* corner of Porter's diamond model is given in Table 36.

Table 36: Multiple Regression Equation for the dependent variable based on the Ability related conditions to compete

Number of papers 2007 – 2011 = 6,577.869 + 3,042.590 (*the Ratio of papers to all staff*) – 686.444 (*Ratio total income to all staff*)

The calculated values of the dependent variables of all the universities in the sample using the *Multiple Regression Equation* in Table 36 did not all exactly correspond to the actual values. The differences between the calculated and the collected values, the *Residual Differences,* were case-wise diagnosed, thereby locating any individual case that diverged widely from the calculated value. Table 37 shows the case where the actual value varied widely from the value that the equation predicted.

Table 37: Case-wise diagnostics

Casewise Diagnostics[a]

Case Number	Std. Residual	Allpapers Nbr papers 2007 to 2011	Predicted Value	Residual
100	3,483	19474	4867,03	14606,970

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

The case-wise diagnostics box in Table 37 shows that there was one case - #100 - whose collected performance varied widely from the value that the *Multiple Regression Equation* predicted. However, based on the source of the data, this was most likely a legitimate case and was therefore not removed.

Figure 55: Histogram of residuals

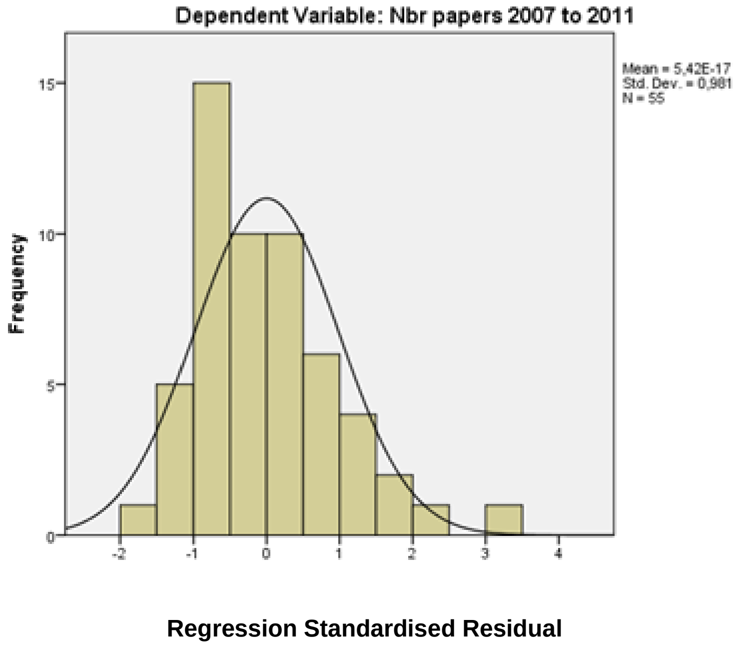


Figure 58 indicates that the distribution of the residual values was neither *Norma*l nor equally centred around zero. The bulk of the residuals were negative, with a very pronounced group between -1 and -0.5. A comparison of the frequency distribution in Figure 58 with that in Figure 37 showed for both a *non-normal* distribution and an over-estimation in the lower values (*non-normality*).

Figure 56: Normal P-P plot of regression standardised residual

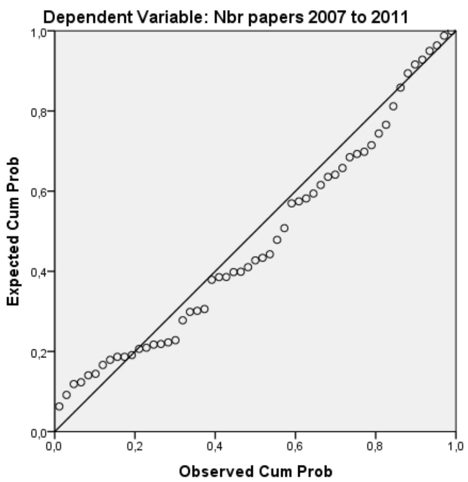


Figure 59 demonstrates that the plot of expected versus actual values clearly diverged/converged from the straight 45 degree line. Here, the equation over-estimated the lowest values and under-estimated the middle values, resulting in an s-shaped curve (*Heterogeneity of variance* or *Heterocedasticity*).

Figure 60 indicates the plot of the collected and calculated performances. The universities in the sample with an actual higher performance than calculated were found in the triangle below the X/Y axes in the figure and the universities in the sample with an actual lower performance than estimated were found in the triangle above the X/Y axes in the figure.

Figure 57: Scatterplot of the actual and estimated performance on the basis of ability related condition to compete

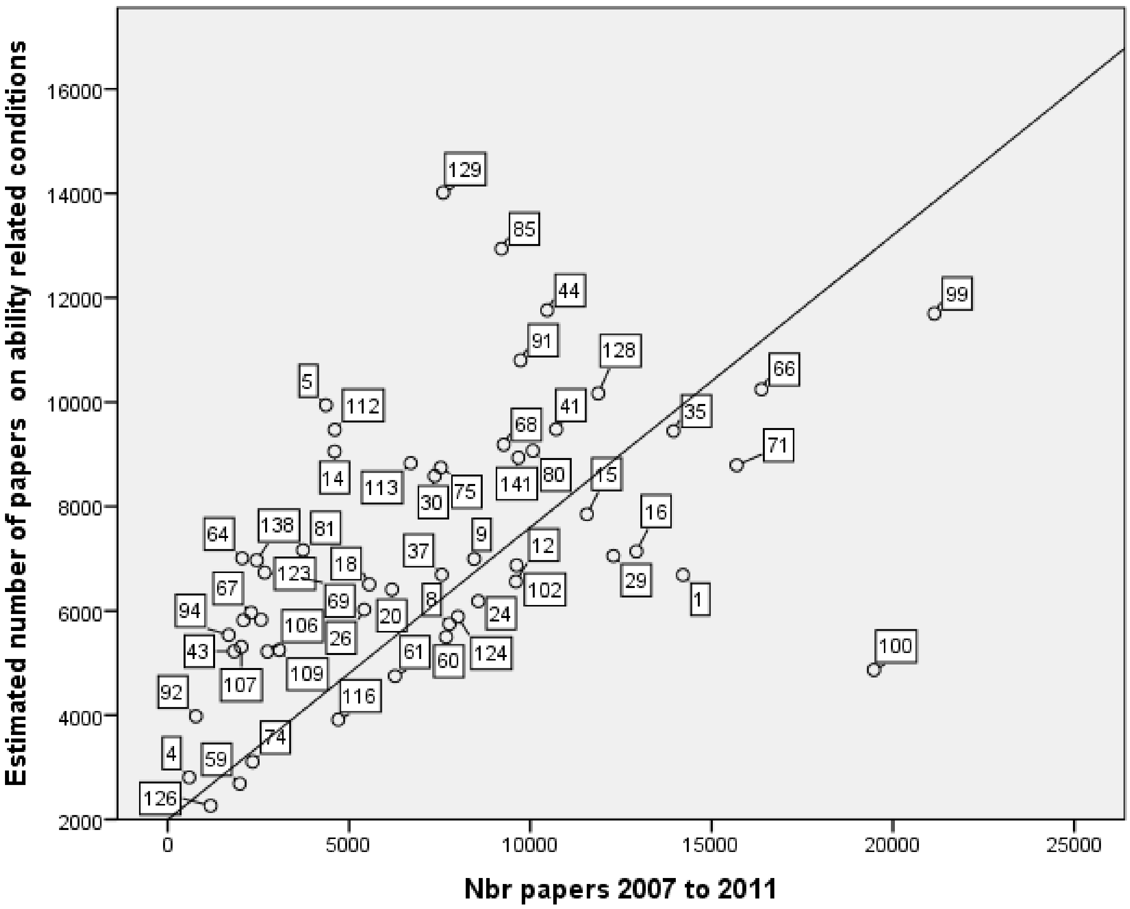


Figure 60 depicts the status of the *Ability related conditions to compete* for each university in the sample. The approximate positions of the universities: under-par, on-par or above-par performing in the *Ability related conditions* corner of Porter’s diamond contribute to the identification of the stage of competitive development of each university in the sample. The identification of the stage of competitiveness for each university is further elaborated in Section 4.3 of this chapter.

The third Null Hypothesis tested was as follows: *There is no statistical significant relationship between the determinants of the corner Collaborator and the role model conditions to compete and performance.* A total of two independent variables constituting the *Collaborator and role model conditions to compete* were entered in the analyses, these being: (1) *the Total number of academic staff* (2) *the Total number of SciVal subject areas* (see Section 2.4.2). None of these two variables were removed in the course of the analysis because their coefficient became non-significant due to the effects of the other independent variables.

Table 38: Model Summary for the MLR analysis of the determinants of the Collaborator and role model conditions to compete.

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	,768[a]	,590	,583	3140,368	,590	84,877	1	59	,000	
2	,822[b]	,676	,665	2813,926	,086	15,483	1	58	,000	1,871

a. Predictors: (Constant), Acadstaffx100 Academic staff x 100

b. Predictors: (Constant), Acadstaffx100 Academic staff x 100, subjareas Subject areas

c. Dependent Variable: Allpapers Nbr papers 2007 to 2011

A comparison of the *R Square* in Table 38 shows that the amount of explained variance improved somewhat in the course of the MLR analysis, from 59.0% to 67.6%. Table 38 further indicated the *Durbin-Watson* statistic = 1.871 (> 1), an indication that the overlap between the constituting independent variables *(multicollinearity*) was not too large.

Table 39: Analysis of Variance (ANOVA) of the final step in the MLR analysis of the Collaborator and role model conditions to compete

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	837047882,6	1	837047882,6	84,877	,000[b]
	Residual	581852725,5	59	9861910,602		
	Total	1418900608	60			
2	Regression	959646246,9	2	479823123,4	60,598	,000[c]
	Residual	459254361,2	58	7918178,641		
	Total	1418900608	60			

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

b. Predictors: (Constant), Acadstaffx100 Academic staff x 100

c. Predictors: (Constant), Acadstaffx100 Academic staff x 100, subjareas Subject areas

Table 39 shows the regression statistic F= 60.598 (F>>0), indicating that the results did not occur by chance. The value of Sig. = 0.000 made clear that a highly significant amount of variance in the dependent variable could be explained.

Table 40: Final solution in the Coefficients box of the MLR analysis of the Collaborator and role model conditions to compete

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1367,813	707,266		1,934	,058		
	Acadstaffx100 Academic staff x 100	276,263	29,987	,768	9,213	,000	1,000	1,000
2	(Constant)	-4180,182	1545,839		-2,704	,009		
	Acadstaffx100 Academic staff x 100	198,161	33,406	,551	5,932	,000	,647	1,546
	subjareas Subject areas	388,172	98,649	,365	3,935	,000	,647	1,546

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

Table 40 reveals the unstandardized B coefficient= - 4180.182. This is the amount of change in *y* by a change of one unit *x* (slope of the regression line). Table 40 further shows the Collinearity Statistics: *the tolerances* were all >0.4 and the *VIF* were all <10, so indicating that the values were within acceptable margins.

Therefore, the null hypothesis: *There is no statistical significant relationship between the determinants of the corner Collaborator and role model conditions to compete and performance* is false and the conclusion that the *Collaborator and role model conditions to compete* influence the research performance was accepted.

The *Multiple Regression Equation* emerging from the step-wise MLR analysis of the independent variables and representing the *Collaborator and role model conditions to compete* corner of Porter's diamond model is given in Table 41.

Table 41: Multiple Regression Equation for the dependent variable based on the Collaborator and role model conditions to compete

Number of papers 2007 – 2011 = -4,180.182 + 198.161 (*Academic staff* x 100) + 388.172 (*SciVal subject areas)*

The calculated values of the dependent variables of all the universities in the sample using the *Multiple Regression Equation* in Table 41 did not all correspond exactly to the actual values. The differences between the calculated and the collected values, the *Residual Differences,* were diagnosed case-wise, locating any individual case that diverged widely from the calculated value. Table 42 shows those cases where the actual values vary widely from the values that the equation predicted.

Table 42: Case-wise diagnostics

Casewise Diagnostics[a]

Case Number	Std. Residual	Allpapers Nbr papers 2007 to 2011	Predicted Value	Residual
99	3,374	21141	11647,76	9493,237

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

The case-wise diagnostics box in Table 42 shows that, as with Table 32 for case #99 and as with Table 37 for case #100, the actual value for the *Number of papers published 2007 to 2011* varied widely from the value that the *Multiple Regression Equation* predicted. However, based on the source of the data, this was probably also a legitimate case and was therefore not removed.

Figure 58: Histogram of residuals

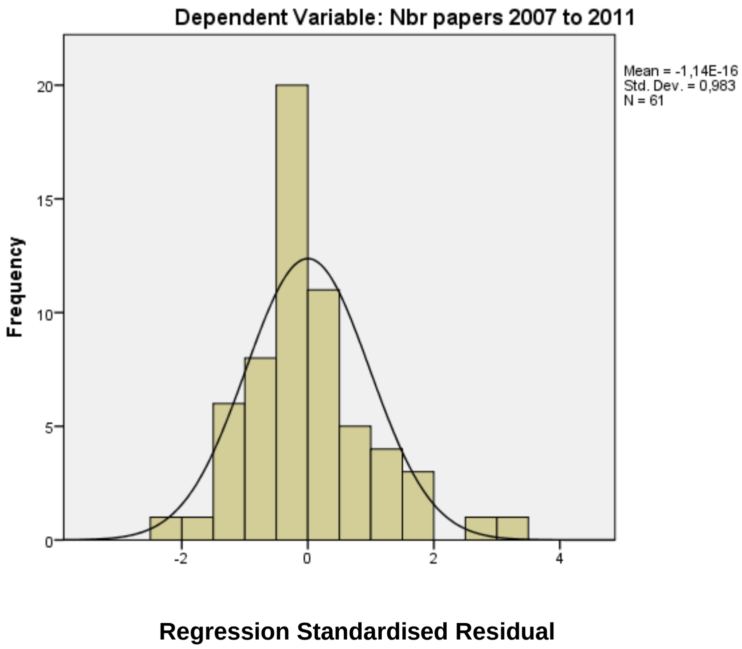


Figure 61 indicates that the distribution of residual values is neither *norma*l nor equally centred around zero. The bulk of the residuals were negative with a very pronounced group between 0 and -0.5. A comparison of the frequency distribution in Figure 61 with that in Figure 37 showed a non-Normal distribution and an over-estimation in the lower values (non-Normality) for both.

Figure 59: Normal P-P plot of regression standardised residual

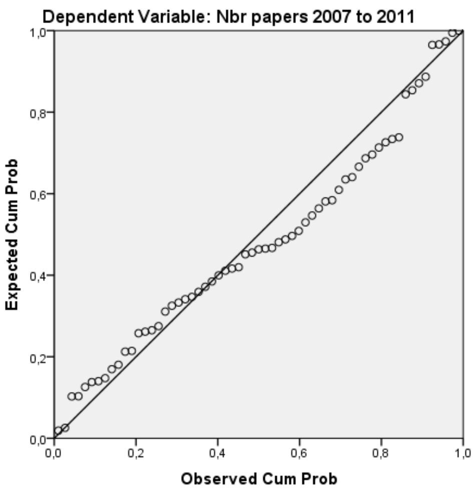


Figure 62 indicates that the plot of the expected versus the actual values clearly diverged/converged from the straight 45 degree line. The equation overestimated the lower values and underestimated the miidle/higher values, resulting in an s-shaped curve (*Heterogeneity of variance* or *Heterocedasticity*).

Figure 63 reveals the plot of the actual and calculated performance. The universities in the sample with an actual higher performance than calculated were found in the triangle below the X/Y axes in the figure and the universities in the sample with an actual lower performance than estimated were found in the triangle above the X/Y axes in the figure.

Figure 60: Scatterplot of the actual and estimated performance on the basis of Collaborator and role model conditions to compete

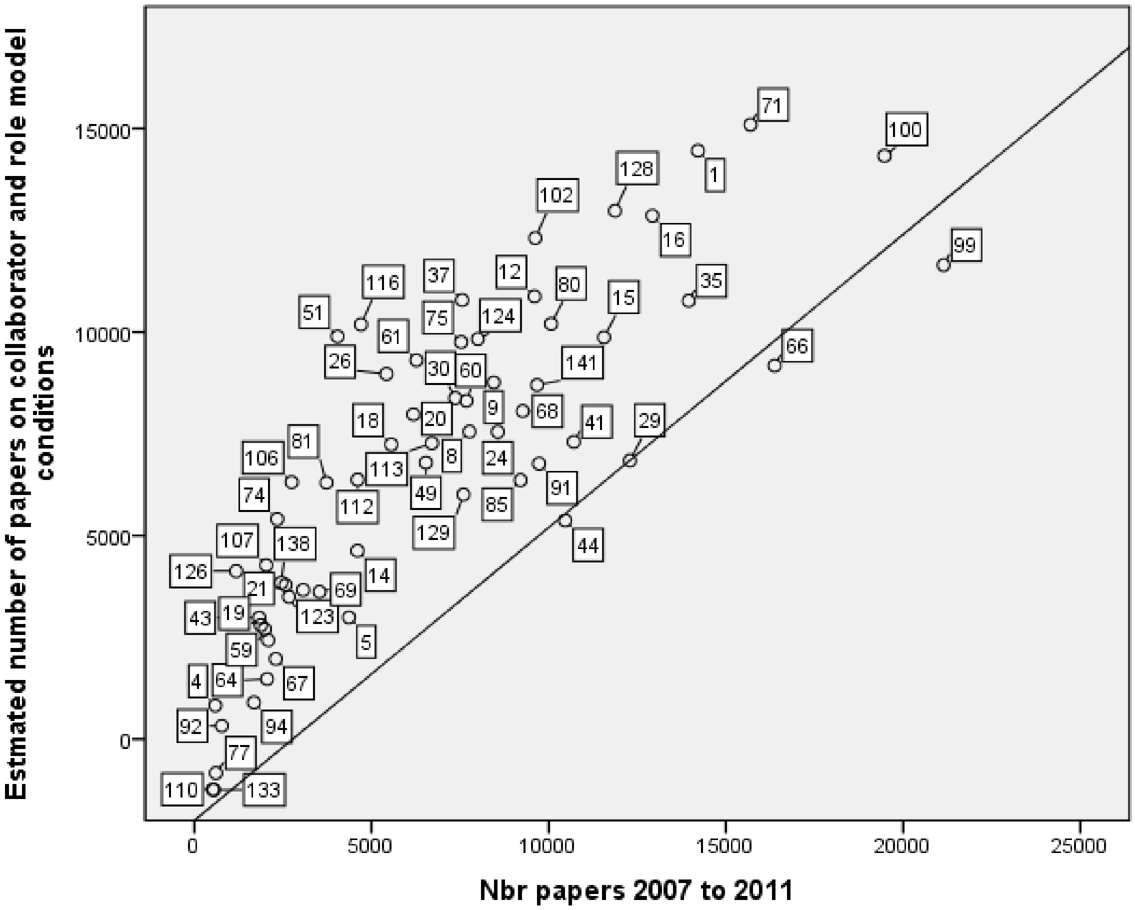


Figure 63 depicts the status of the *Collaborator and role model conditions to compete* of each university in the sample. Here, the approximate position of the universities: under-par, on-par or above-par performing in the *Collaborator and role model conditions* corner of Porter’s diamond, contribute to the identification of the stage of competitive development of each university in the sample. The identification of the stage of competitiveness for each university is further elaborated in Section 4.3 of this chapter.

The fourth Null Hypothesis tested was: *There is no statistical significant relationship between the determinants of the corner Strategy, structure and rivalry conditions to compete and performance*. A total of four independent variables, these constituting the *Strategy, structure and rivalry conditions to compete* were entered in the analyses. These were: (1) the *Total number of authors*; (2) the *Total number of staff*; (3) the *Total number of non-academic staff* (4) the *Total number of doctoral degrees awarded.* Two independent variables were removed in the course of the analysis because their coefficient had become non-significant due to the effects of the other independent variables: (1) the *Total number of non-academic staff* (2) the *Total number of doctoral degrees awarded.*

Table 43: Model Summary for the MLR analysis of the determinants of the Strategy, structure and rivalry conditions to compete

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	,920[a]	,847	,844	1871,453	,847	276,842	1	50	,000	
2	,940[b]	,883	,879	1650,340	,036	15,296	1	49	,000	1,858

a. Predictors: (Constant), Authorsx1000 Authors x 1000

b. Predictors: (Constant), Authorsx1000 Authors x 1000, Allstaffx100 All staff x 100

c. Dependent Variable: Allpapers Nbr papers 2007 to 2011

A comparison of the *Adjusted R Square* in Table 43 shows that the percent of explained variance did not improve much in the course of the MLR analysis, this developing only from 84.7% to 88.3%. Table 43 also shows the *Durbin-Watson* statistic = 1.858 (> 1), an indication that the overlap between the constituting independent variables (multicollinearity) was not too large.

Table 44: Analysis of Variance (ANOVA) of the final step in the MLR analysis of the strategy, structure and rivalry conditions to compete

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	969594715,7	1	969594715,7	276,842	,000[b]
	Residual	175116757,3	50	3502335,147		
	Total	1144711473	51			
2	Regression	1011253920	2	505626959,9	185,645	,000[c]
	Residual	133457553,4	49	2723623,538		
	Total	1144711473	51			

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

b. Predictors: (Constant), Authorsx1000 Authors x 1000

c. Predictors: (Constant), Authorsx1000 Authors x 1000, Allstaffx100 All staff x 100

Table 44 shows the regression statistic F= 185.645 (F>>0), so indicating that the results did not occur by chance. The value of Sig. = 0.000 demonstrated that a highly significant amount of variance in the dependent variable could be explained.

Table 45: Final solution in the Coefficients box of the MLR analysis of the strategy, structure and rivalry conditions to compete

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	789,395	481,861		1,638	,108		
	Authorsx1000 Authors x 1000	822,854	49,455	,920	16,639	,000	1,000	1,000
2	(Constant)	-10,752	471,617		-,023	,982		
	Authorsx1000 Authors x 1000	640,040	63,929	,716	10,012	,000	,465	2,149
	Allstaffx100 All staff x 100	56,001	14,319	,280	3,911	,000	,465	2,149

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

Table 45 shows the unstandardized B coefficient= - 10.752. This is the amount of change in *y* by a change of one unit *x* (slope of the regression line). Table 45 further indicates the Collinearity Statistics: the *Tolerances* were all >0.4 and *the VIF* were all <10 so indicating that the values were within acceptable margins.

Hence, the null hypothesis: *There is no statistical significant relationship between the determinants of the corner Strategy, structure and rivalry conditions to compete and performance* is false and the conclusion that the *Strategy, structure and rivalry conditions to compete* influence the research performance is accepted.

The *Multiple Regression Equation* emerging from the step-wise MLR analysis of the independent variables representing the *Strategy, structure and rivalry conditions to compete* corner of Porter's diamond model is given in Table 39.

Table 46: Multiple Regression Equation for the dependent variable based on the strategy, structure and rivalry conditions to compete

Number of papers 2007 – 2011 = -10.752 + 640.040 (*Total authors* x 1,000) + 56.001 (All *staff* x 100)

The calculated values of the dependent variables of all universities in the sample using the *Multiple Regression Equation* in Table 46 did not all correspond exactly to the actual values. The differences between the calculated and the observed values, the *Residual Differences,* were diagnosed case-wise, locating any individual cases that diverged widely from the calculated value. Table 47 sets out the case where the actual value varied widely from the value the equation predicted.

Table 47: Case-wise diagnostics

Casewise Diagnostics[a]

Case Number	Std. Residual	Allpapers Nbr papers 2007 to 2011	Predicted Value	Residual
71	3,701	15691	9582,77	6108,229

a. Dependent Variable: Allpapers Nbr papers 2007 to 2011

The case-wise diagnostics box in Table 47 shows that for case #71 the collected value for performance varied widely from the value the *Multiple Regression Equation* predicted. However, based on the source of the data, this was most likely a legitimate case and was therefore not removed.

Figure 61: Histogram of residuals

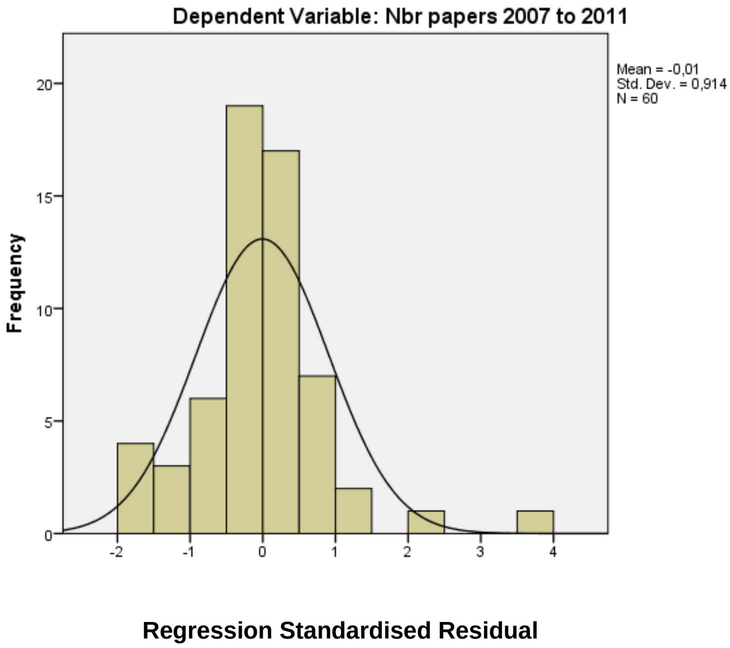


Figure 64 shows that the distribution of residual values resembled a *normal* distribution, with frequencies tending to centre around zero.

Figure 62: Normal P-P plot of the regression standardised residual

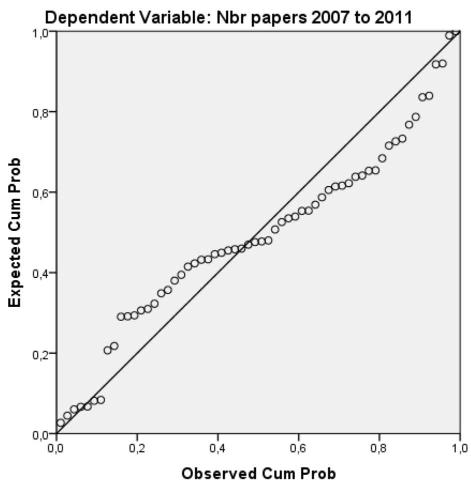


Figure 65 indicates that the plot of the expected versus the actual values clearly diverged/converged from the straight 45 degree line. In the middle of the graph, the equation over-estimated the lower values and under-estimated the higher values, resulting in an s-shaped curve (*Heterogeneity of variance* or *Heterocedasticity*).

Figure 66 shows the plot of the actual and calculated performance. The universities in the sample with a higher collected performance than the calculated performance were found in the triangle below the X/Y axes in the figure, and the universities in the sample with a lower collected performance than the estimated performance were found in the triangle above the X/Y axes in the figure.

Figure 63: Scatterplot of the collected and estimated performance on the basis of their Strategy, structure and rivalry conditions to compete

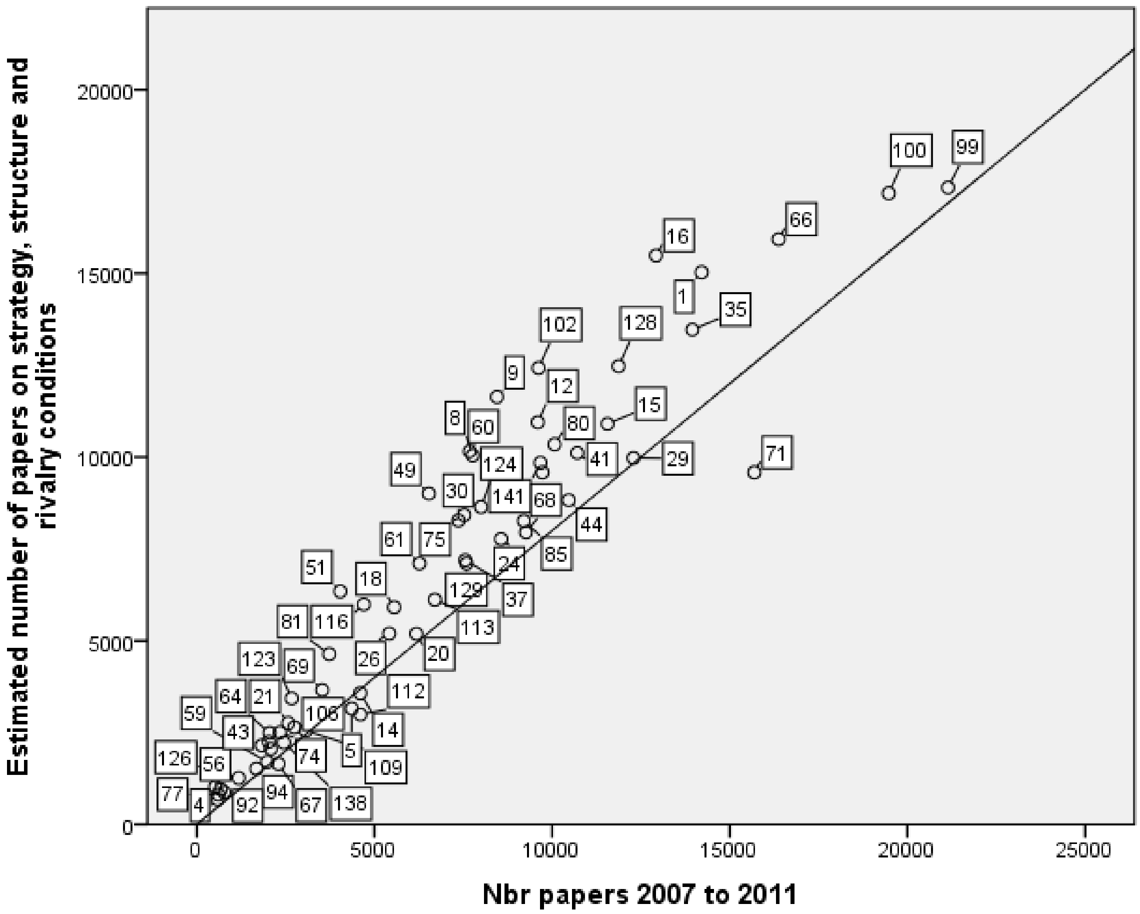


Figure 66 depicts the status of the *Strategy, structure and rivalry conditions to compete* of each university in the sample. The approximate position of the universities: under-par, on-par or above-par performing on the *Strategy, structure and rivalry conditions to compete* corner of Porter's diamond contribute to the identification of the stage of competitive development of each university in the sample. The identification of the stage of competitiveness for each university is further elaborated in Section 4.3 of this chapter.

Qualitative information pertaining to the deviations of the universities from the regression lines in Figures 57, 60, 63 and 66 was collected via field interviews held at German universities; this is presented in Section 4.3 (Qualitative Analysis) of this chapter.

4.2.5 Summary of Quantitative Data Analysis

The aim of the quantitative data analysis was to explain the impact of the determinants on universities' competitive advantage. This aim drew on the first part of the research question (while the following qualitative data analysis draws on the second part of the research question). To this end, 15 determinants were analysed. The data was collected from a sample including 59-73 German universities (depending on the nature of the data). From the archival data collection, it emerged that many universities did not publicly report their performances and other pertinent data.

Initially, the descriptive statistics were presented. From the histograms presented, it emerged that the highest frequencies were found with the lowest performers. The visual inspection of the histograms pointed toward multiple categories of universities in the sample. To identify the different clusters among the sample members, a *K*-means cluster analysis was carried out, identifying 3 clusters of universities and one outlier. It further emerged from the histograms that the distributions of scores based on funding were similar to the distribution of the scores based on performance, with the distribution of scores based on teaching funding being the most similar. Additionally, the distribution of scores based on investment in scholarship (through annual library expenditure) differed from the distribution based on funding, suggesting that investment in scholarship was governed by other considerations than funding alone. It also emerged that the distributions of the scores based on the ability to generate income were similar to the distribution of scores based on the ability to publish research output.

From the calculation of the measures of central tendency, it was apparent that the *average* university in the sample had a size of 3,600 staff members, of which 52% were academic, and an annual income of €254M, of which 70% was teaching income and 29% research funding; 3% of its budget was spent on the library. The funding per staff member was *on average* €77K per year and the *average* research output per academic staff member was 0.75 paper per year.

To explore the extent to which each of the 15 tested determinants of the 4 corners of the diamond were most important for predicting what the most likely condition of a corner would be, four step-wise multi-regression analyses were performed. The outcomes of these analyses were presented in the format of four multiple regression equations, each including all the determinants with a significant effect upon the condition of that corner. The determinants with no significant effect on the condition of the corner were excluded in the course of the analysis. Following this, scatterplots were computed in which the *estimated* performances, these being calculated with the regression equations, were plotted against the collected values of performance to identify under-par, on-par, and above-par performers. The conditions of all four corners together provided the condition for the whole diamond for that university. The latter is indicative of the stage in the process of development of competitive advantage generated by research for that university, and this is elaborated on further in Section 4.3 of this chapter. A summary of the outcomes of the testing of the 4 sub-null hypotheses is presented in Table 48.

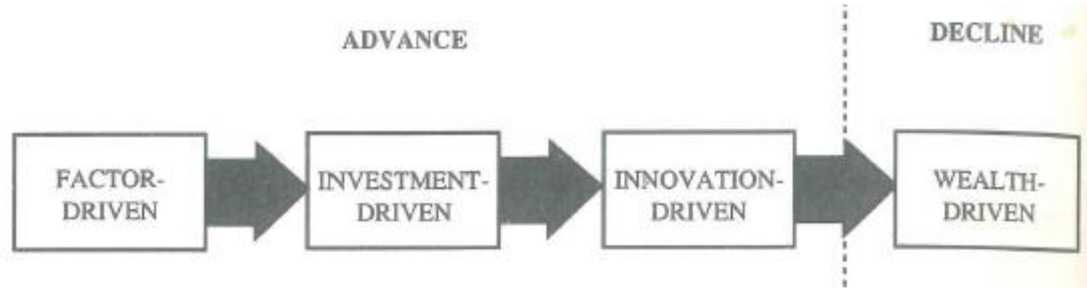
Table 48: Summary of sub-null hypothesis testing

Sub-null hypothesis	**False/True**
There is no relationship between the determinants of the corner *Basic conditions to compete* and performance.	False
There is no relationship between the determinants of the corner *Ability related conditions to compete* and performance.	False
There is no relationship between the determinants of the corner *Collaborator and role model conditions to compete* and performance.	False
There is no relationship between the determinants of the corner *Strategy, structure and rivalry conditions* and performance.	False

4.3 Qualitative Analysis

The objective of the qualitative data analysis drew on the research question and concerned helping '*to understand the dynamic process by which university competitive advantage in research is created and upgrading is enabled'.* For this purpose, the qualitative analysis was framed within Porter's model of competitive development, including four successive stages of competitive development, these being: (1) *factor-driven*; (2) *investment-driven*; (3) *innovation-driven*; (4) *wealth-driven*, as shown in Figure 67.

Figure 64: Porter's four stages of competitive development



Porter, 1998, p. 546.

The model offers a way of understanding how competitiveness develops. Porter affirms that not all the subjects of evaluation necessarily pass through the stages, and the stages do not purport to explain everything, since no subject of investigation will fit a stage exactly (Porter, 1998, p. 546). Despite these caveats, the model provides the opportunity to identify an emerging pattern in the process of competitive development. Here, the nature of competitiveness in a particular stage of competitive development is depicted by the state of the diamond (Porter, 1998, p. 546) as presented in the Figures 68 – 71.

Figure 65: The factor-driven stage.

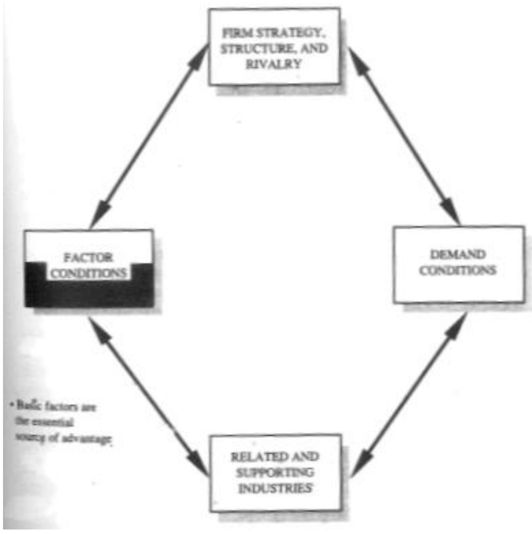


Figure 66: The investment-driven stage

Figure 67: The innovation-driven stage.

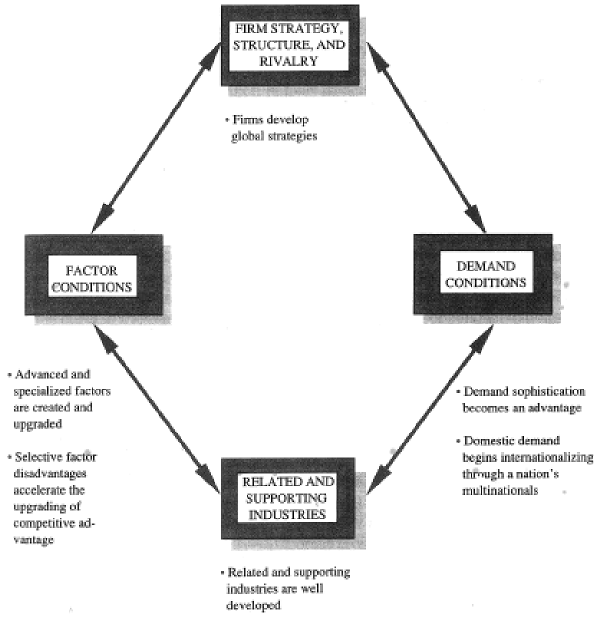
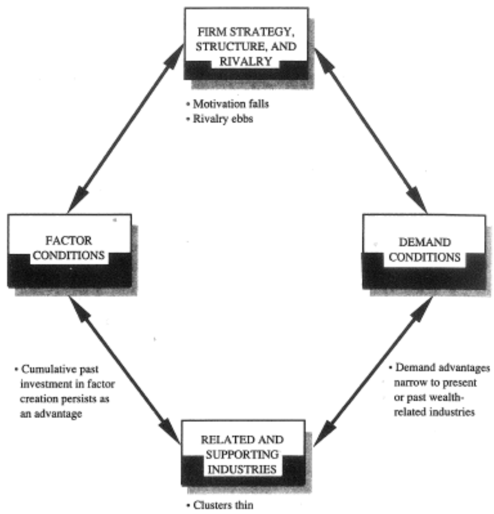


Figure 68: The wealth-driven stage



Porter 1998, pp. 547, 550, 553 and 558[28].

[28] The naming of the four stages of competitive development follows the writing conventions as used by Porter (1998, pp. 546, 548, 552 and 556).

The following sections of this chapter present the findings of the thematic analysis of the semi-structured interviews. These were conducted with the university executives responsible for research policy to collect the data. For the thematic analysis, notes taken in the course and directly after the interviews and recordings of the interviews were reviewed to ensure a thorough account of the interview responses. The most salient extracts from the interviews are presented in the following sub-sections of this chapter.

The preparation of the account of the interviews included noting down *initial* codes which represented interesting features of the data that could form the basis of repeated patterns in the data. After the collection of the *initial* codes, these were sorted into potential *topical* codes or *themes*. This showed how different *initial* codes could be combined into overarching *topical* codes, after which an initial thematic map depicting the relationships between the *topical* codes was drawn. In the next stage, the account of the interview responses was reviewed to see if there was sufficient evidence to support the *topical* codes. If this was not the case, the *topical* codes were deleted, or if additional *topical* codes emerged, these were added to the list. The outcome of this exercise was a list of *topical* codes and their underpinning assumptions for each stage of competitive development. The analysis was concluded with the drawing of a *final* thematic map identifying the relationships between the *topical* codes (see also Section 3.4.4 and Braun and Clarke, 2006, pp. 77-101). The outcome of the thematic analysis by means of tables of *topical* codes and thematic maps for each of the four stages of competitive development is presented in the following sub-sections of this chapter.

4.3.1 The Factor-Driven Stage

Interviewees were asked how far the competitive advantage generated by research of their university was based on favourable geographical and/or historical conditions and in what manner they were vulnerable to (inter-)national economic cycles and/or shifting research leadership.

The first interviewee was the Vice Chancellor of Research and Innovation at a university belonging to Cluster 3 (universities with a mean annual income of € 340 million, see Table 25). He pointed out how this university is a relatively young university which was established in the mid-1960s as the successor to a Medical Academy founded in the early 1900s.This university did not have substantial endowments like, for example, Harvard or Stanford and because of this is the university highly dependent on its governmental sponsors. The first interviewee further maintained that all German universities are already structurally underfinanced and he feared a continuing downturn in the country's economy could influence university funding by the government. Because of this, a dependence on external research grants was becoming increasingly important and the success rate of his grant applications had been negatively influenced by the unfavourable economic conditions in the world. Despite these caveats, the first interviewee considered that the situation in Germany was still very good compared with the rest of the world. However, the university's geographical location in a highly industrialised part of the country did not provide a competitive advantage with regard to research areas or external research funding.

The second interviewee was the Vice Chancellor of Research at a university belonging to Cluster 2 (universities with a mean annual income of €131 million, see Table 24). On the issue of favourable geographical and/or historical conditions, the second interviewee maintained that the foundation of this university by the end of the 1970s and the existence of a University of Applied Sciences had positively influenced the arrival of some very large industries in the area. Examples of these are BMW, Siemens, Continental, Osram, etc., which, in turn, had created job opportunities for graduates and, to a lesser degree, research opportunities.

She further highlighted the strong support for the university by the city. For example, a former army barracks that was the property of the city was transformed into a technology campus and the city provided the university and the University of Applied Sciences with the grounds for a new school of engineering. Here, she was quoted as saying: "We have a favourable environment. The support of the city and the flourishing economy is, for sure, a big help. … You don't lose your best people: they stay here".

By elaborating further on favourable conditions she highlighted that in Germany, in contrast to other countries, successful researchers who want to make a career must look outside their own Alma Mater. At this university, however, some successful researchers had the opportunity of a higher ranked position elsewhere but stayed because they were offered more working space, an increased salary and could even become the head of a department without a higher formal rank. Consequently, people could have the *benefit* of, for example, a tenured professor position without having the *rank* of a tenured professor. This is important because in Germany only the government can appoint tenured professors and not the university itself.

On the economic environment, the second interviewee maintained that:

"Because the economy is going well we can attract lots of grants … offer our people … money for the research and very good salaries so they will like staying here".

With regards to the research funding, the second interviewee commented:

"Because the DFG [German Research Foundation] is working so well … Germans typically apply for grants from the DFG and not from the European Research Council. … 2009 was also for Germany a problem … nevertheless research funding was never cut, maybe because Mrs. Merkel is a physicist … and knows how important research is for Germany".

The third interviewee was the Head of the Division for Research Information Management at another university belonging to Cluster 3 (universities with a mean annual income of € 340 million, see Table 25). This interviewee referred to the long history of the university (which was founded in 1780 from a Jesuit college established in 1588) so explaining its focus on the Humanities. Unfortunately, the long history of the university had not resulted in substantial financial bequests. On this theme, the third interviewee is quoted as saying:

"Although the university has some private capital on saving accounts … this does not make us less dependent on governmental funding … The reduction in regular governmental funding forced us to compensate for this with project research funding (Drittmittel) to keep the research staff on the pay role. However, we are limited in our expansion because this always requires

additional funding from the university itself. Currently, only 11% of the research funding is from industry, the remainder coming predominantly from the DFG and the BMBF [Federal Ministry of Education and Research] and a smaller part from the EU … About 2/3 of the research funding is for the projects in the Humanities, where the funding for projects […] is significantly less than for projects in the natural sciences."

The prevailing financial downturn in the world had a negative impact on research funding by the industry, but this did not influence governmental funding. The latter, however, was negatively influenced by the formation of a new administration after the last elections which led to a delayed approval of the ministry's budget.

The third interviewee further highlighted how the business environment of the university consisted largely of offices, with no large-scale industries. Interestingly, despite the absence of such industries, this being a *factor-disadvantage*, the chemistry faculty of this university belonged to the largest and most famous in Germany. Another *factor-disadvantage* mentioned was the presence of only one Max Planck and one Leibniz institute[29] offering limited additional thrust to the research performance of the university.

The fourth interviewee was a staff member of the Controlling, Organisation and Planning Department at a university belonging to Cluster 4 (universities with a mean annual income of € 1.095 million, see Table 26). She highlighted as a favourable *factor condition* the immediacy of the university to industry and the historically national focus of German engineers. The former can be seen in a focus on feasibility, market needs and cooperation; the latter required the strong vision of the university to focus on international developments so as not to lose the connection with international developments. The fourth interviewee made the following statement:

"It is of course the task of the university to tell the industry that they should do everything correctly and that they are very successful, but the university must also tell the industry that the world keeps spinning and whereas today the automotive industry is the focus of everything, tomorrow other industries may be

[29] Max Planck and Leibniz institutes are world-class nation-wide research institutes.

more important, and therefore our university is very keen to make the connection with international development in a wide range of research areas".

With regard to the size of the university, the fourth interviewee asserted that until the mid-1990s the growth of the university was stationary. The recognition by the university that a critical mass in the number of students, staff and funding is essential to play a leading role on the international stage has since led to an increase in the number of students by over 30%.

The fourth interviewee also argued that in contrast to industry research funding, governmental funding of universities in Germany was not influenced to any great degree by world economic cycles. She particularly believed that those universities receiving Excellence[30] funding were in a relatively favourable financial position. The basic funding of this university comes from the federal state of Bavaria for teaching and some research, whereas additional research funding (Drittmittel) comes from the national government and third parties. The fourth interviewee stated that the additional research funding exceeds the basic funding and expressed the following view:

"In the end it comes down to the universities no longer being adequately financed by the government. At best, the basic funding by the federal states is stationary, and third party funding is increasingly important".

The fourth interviewee introduced a far more serious problem: the built environment of German universities. Many universities were built in the 1970s when the government fostered the expansion of universities, and now fifty years later, they require major renovation and extensions for which no additional funding is provided.

Table 49 presents the topical codes/themes where the topics emerging from the interview responses were coded with their underpinning assumptions or meanings.

[3030303030] "The Excellence Initiative is intended to strengthen Germany as a location of excellent science and humanities, to enhance its international competitiveness and to increase the visibility of top-level universities and research areas. The Excellence Initiative is conducted by the German Research Foundation and the German Council of Science and Humanities" (Wissenschaftsrat, no date).

Table 49: Topical codes and their underpinning assumptions

Topical code	Underpinning assumptions
Government's role	Few opportunities for upgrading independent of government funding.
History of institution	Foundation of current competencies; bequests making institute less dependent on government generally absent.
Favourable economic conditions	Presence of sufficient national funding determines the extent of competition for funding; national economic condition may influence funding practices; sufficient funding enables people to stay.
Favourable geographical conditions	Makes location attractive for labour force; people like work here.
Presence of industry	Offers job opportunities for graduates; industry funding makes institutes less dependent on government.
Natural sciences / arts & humanities balance	Determines average funding level.
Presence of national research institute (e.g. Max Planck)	Offers additional thrust for upgrading.

Elaborating on the essence of each code and its underlying assumptions resulted in the identification of 2 overarching themes and 7 main topical codes/themes. Their relationship in this stage of competitive development is depicted in the *thematic map* presented in Figure 72.

Figure 69: Thematic map showing the key themes in the factor-driven stage

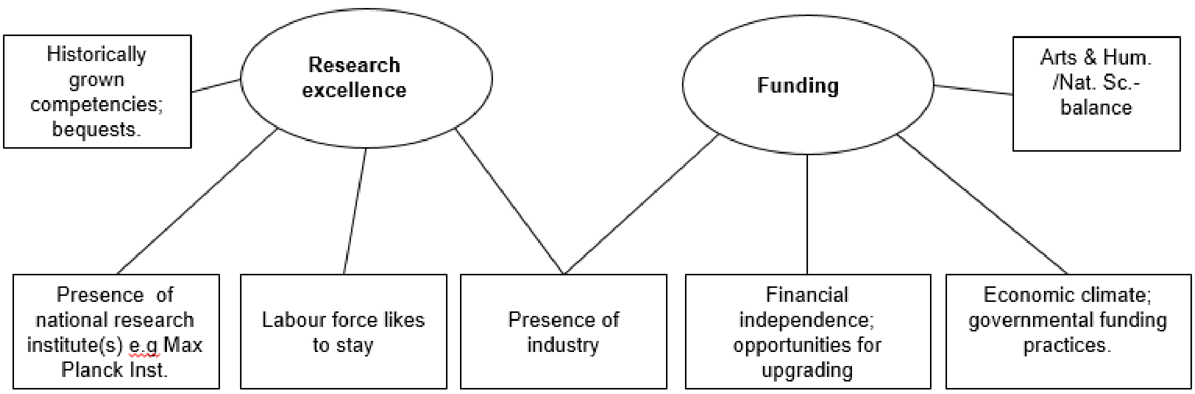


Figure 72 depicts the two overarching themes in the factor-driven stage: *Existing research excellence* and *Funding*. The *Existing research excellence* is rooted in the historically grown size, financial and research strength. *Existing research excellence* is propelled by the presence of nationwide research institutes, such as Max Planck, Fraunhofer, Helmholz, etc., whereas the presence of industry provides job opportunities for graduates and post-doctorate and research opportunities. The existing research *funding* situation is rooted in the nation's financial situation and the balance between Natural sciences and Arts & Humanities. The opportunities for upgrading competitive research strengths are largely determined by the government. Here, the Government's role at this stage is substantial. Examples of this are Excellence Initiatives or Focal areas initiatives ('Sonderforschungsbereiche') where the internal professionalization of the research funding application process is fostering increased success rates.

4.3.2 The Investment-Driven Stage

The interviewees were asked: how far the development of their competitive advantage was informed by benchmarks set by other universities; what large scale investments were made to upgrade their competitive advantage; how far the university had increased its skilled labour pool and was improving international developments as well as developing channels to have their research published.

The first Interviewee responded to the issue of national benchmarking and governmental influence:

"The easy answer in Germany is the Excellence Initiatives. Of course the Excellence Initiatives determine everything. We were not successful in the first round, but have built a cluster with a nearby university and now play successfully in another league with a joint Excellence Cluster. The Excellence Initiatives have dramatically changed the research landscape in Germany. Either one is part of it or not. There are now three leagues in Germany: the champions league with those who have an elite status such as LMU, TUM, HU

Berlin, Bremen, Heidelberg, … the second league with those who have an Excellence cluster or an Excellence [Graduate] *School, and the amateur league with those who have nothing."*

As regards national benchmarking, the first interviewee also expressed the following view:

"Of course one looks at what other universities have done, but you must massively adapt your strategy. We have 12 professors in Physics, the LMU has 48, and with 48 professors I can pursue a completely different strategy to a situation with 12. With regards to benchmarking, look at the others… but you must modify and optimise for local circumstances."

The first interviewee further explained that this university had strategically invested in infrastructure and staff to reach the excellence cluster status with which the university had focused on existing staff. However, after reaching the desired excellence status, the professors were moved, new professors were recruited and new infrastructures were built to further pursue the university's expansion strategy. With regard to current research trends, the university is following and improving its current leading areas so that a university's management does not require its researchers to participate in 'hot' topics.

An estimated number of about 20 editorial contacts from about 2,000 academic staff (1.0%)[31] provided this university with access to channels to publish its research output. The editorial activities were encouraged by the university management who realised that they cannot enforce the direction of their researchers. A University Press was founded in 2007 with the aim of strengthening the competitive advantage of the university.

As regards the advantages of the presence of national research institutes, the first interviewee pointed out that such world leading research institutes have the interest and the funding to appoint (potential) Nobel prize laureates to whom they offer teaching-free research positions. When these researchers participate in Collaborative Research Centres (Sonderforschungsbereiche (SFB)) together with universities, this propels the upgrading of the university.

[31] In the present research is the estimate based on the number of Elsevier editorial contacts.

The first interviewee maintained that the potential for upgrading research performance is largely determined by the size of the university, and therefore larger universities have a greater potential for upgrading. The upgrading of research performance does require however additional professors whereas only the government decides on the number of professors and not the universities. Interviewee One believed it is unlikely that the government will increase the number of professors. Hence, the opportunities for upgrading are limited by the government's willingness to cooperate. On the topic of growth, the first interviewee was quoted as saying:

"Growth to significantly change is in my opinion … de facto not possible in Germany unless governments close down universities and shift the released positions to other universities, and I do not believe that any government in Germany is willing to do this. One can of course dismiss middle staff and replace these with professors, but that will lead to professors without staff. … Increased external research funding does not lead to more professors, apart from being part of the Excellence Initiatives which allows the recruitment of more professors for five years; hereafter these professors must be replaced by the university's professors. Thus, the net growth is zero. … The current size of the largest universities in Germany is the result of a long period of historical growth. I also claim that at the leading universities there are relatively [speaking] as many smart professors as at the other universities, but their sheer size allows the larger universities an easier establishment of Collaborative Research Centres (SFB's); this explains the direct correlation between size and performance, because larger universities can create more substance with the same distribution of intelligence as smaller universities".

The second interviewee described the university's upgrade strategy. She was quoted on this theme as follows:

"We really decided to specialise very much … all the new professors we employed in the last years were really according to the strategy of the department becoming very strong and achieving a critical mass in specific fields… and having achieved his critical mass, we could apply for national funding and were very successful. Of course you choose to have a competence area which is complementary, typically [close] to that of neighbouring

universities. These kinds of competencies in some fields are specific for our university .. Due to this strategy which we have followed in the last ten years, were we able to be so good and so specialised in these fields that we got these grants."

Decisions on where to focus in a five year period were made at the faculty and departmental level: *"I cannot decide what my colleagues for example in the law department are going to do; they know by themselves".* Openings for professors were fulfilled by recruitment in the chosen areas. Here, the university strategy was supported by the university administration, providing new professors with sufficient funding to build up-to-date laboratories. Large scale investments were made to support specific research fields through, for example, the construction of a new clean room. These investments were returned when the researchers, benefitting from an excellent infrastructure, applied successfully for starting and advanced grants and brought extra money to the university.

On the topic of benchmarking with other universities, the second interviewee declared :

"You cannot really compare for example LMU [Ludwig-Maximilians-University of Munich] with our university because LMU is twice as large, is much better politically connected and is a historically grown university… They can also afford to specialise in certain areas and at the same time cover everything because they have more manpower … I therefore think it is not wise to compare. What we did is take specific research areas and then compare… and I think that as a result we did better than LMU, in the period 2008 to 2010 as far as funding was concerned… We could not get special funding for example from the Excellence Initiatives because we are not so large and we do not have Max Planck or Fraunhofer Institutes here, but nevertheless, because of the strategy we followed in the last 10 years were we able to be so good and so specialised in certain fields that we got these grants."

The university pool of skilled researchers and technical personnel had significantly increased over the last years in response to more students coming into the university. This extra influx of students was the result of a reduction in Germany of the number of years spent in a gymnasium (from nine to eight years) and the abolishment of obligatory military service. Because the number of professors was based on the number of students per professor, the influx of more students resulted in more professors. Teaching funding in Germany is a matter for the federal states (Länder) and differences may occur between the various federal states. Research funding, however, is mainly from the central government (Bund) via the Research Foundation (DFG) with relatively small contributions from the federal states.

The university did not establish a university press but relied on peer reviewed journals as a channel to have research published. The estimated number of editorial contacts at this university is about 15 for an academic staff of about 1,700 (0.9%).

The third interviewee reported that his university was benchmarking using national rankings. For example, the DFG Funding Atlas was used for the validation of the internal assessment of the competitive condition of the university, but benchmarking was not used for the development of the research portfolio. On the theme of profile development, the third interviewee stated:

“Recently, the German Research Council (Wissenschaftsrat) has made a recommendation for a further development of the German science system, including a very clear recommendation for universities to engage in profile building more strongly ... This is for me a clear confirmation that currently there is hardly any profile development at German universities … Nowadays, many universities do not have a research profile; they regard their larger research areas automatically as key research areas regardless of whether these are also thematic competence areas.”

The third interviewee recognised three stimuli for profile development at German universities: (1) the *Excellence Initiatives* requiring from the applicants a *strengths and weaknesses* analysis; (2) a survey held in 2011 by the German Chancellor’s conference (*Rektorenkonferenz)* investigating profile development and research strengths; (3) a recent pilot study conducted by the German Research Council (Wissenschaftsrat) and benchmarking four research areas nationwide. He further argued that benchmarking was at that time only taking place at smaller universities that were capable of rapid change, as for example the Leuphana University (belonging to Cluster 2, this denoting universities with a mean annual income of € 131Million. See Table 24).

The third interviewee presented two examples of the university's investments in order to upgrade her research performance, these being: (1) the development of the two *Excellence clusters*; (2) the development of the focal area *battery research* (Batterie Forschung). Within the context of the application for the *Excellence cluster* status, the thematic focal areas created also encompassed research areas that were not researched at that time. However, the university committed itself to this in the event of a successful application for the *Excellence cluster* status to hire new professors, which after initial financing by the *Excellence cluster* funding would be further financed by the university itself. The application did not require proof of the availability of an appropriate infrastructure, and thus large-scale risky investments in the infrastructure were avoided. The only direct investments were the labour costs for support staff for professors writing the application. The development of the focal area *Battery Research* was initiated by the university itself and based on the presence of a strong chemistry faculty. Funding by the Federal state was used to establish a complete research centre in the expectation that this research field would develop into a key research area where, for example, income from patents would provide the desired Return on Investment.

The labour pool from the university of the third interviewee had increased from 4,500 to 7,200 (+60%) in the previous five years mainly as a result of the expansion of research funding (Drittmittel), from € 80 million to > € 120 million. Of the research funding, on average about 80% was spent on personnel costs. The reduction of the compulsory school attendance and the abolishment of the military service leading to more students (alluded to earlier) had also contributed to the expansion of the university labour pool.

The third interviewee remarked on the university's strategy to expand her research portfolio in the following way:

"There is a so-called innovation budget to stimulate new ideas and project proposals. Applicants are supported by a consulting committee of the chancellor (Forschungsbeirat) to ensure high quality and successful applications in those research areas fitting the research agenda of the university."

The university of the third interviewee did not have a university press, merely a book series, this primarily being used for the publication of theses. The university relied on peer reviewed journals as a channel through which her research could be published. The estimated number of editorial contacts at this university was about 12 with an academic staff of about 4,600 (0.3%).

The fourth interviewee maintained that the upgrading of research performance was informed by referring to benchmarking, this being (1) voluntarily executed at faculty level, (2) regularly executed at university level by the university management. In this way, the university was compared with its *alliance* partners and with the ETH (Eidgenössische Technische Hochschule Zürich), this occasionally being executed around certain themes. It was revealed that the university is considering using an independent third party for support with its benchmarking and research performance evaluation. One of the key issues emerging from benchmarking is the lack of robustness of the bibliographic data, this being caused, for example, by the name variations of authors and leading to incorrect indicators.

The fourth interviewee explained how the upgrading of the competitive condition was (at least in part) the result of large scale investments. Examples of this are a reactor for the physical sciences and the creation of a number of research centres, such as a centre for Agricultural Science, the latter building a bridge between basic agricultural research and practical applications of that research. On the theme of large scale investments to upgrade the condition of research, she declared:

"The theme of electro-mobility would not have been possible if we had not created the science centre electro-mobility, but I would not view this too absolutely."

The fourth interviewee further highlighted that the academic staff had significantly increased over the years in contrast to the non-academic staff. This increase was the result of increased student numbers which led to more teaching positions so that the number of non-academic support staff dropped behind. Here, recruitment for academic (science) management positions outside the classic finance and human resources departments is still very difficult if these positions cannot (at least in part) be used for teaching purposes.

On the topic of channels to publish research results, the fourth interviewee indicated the absence of an explicit strategy. The university lacks a university press and relies on peer reviewed journals as a channel to obtain its published research. The estimated number of editorial contacts at this university is about 20 from about 4,6000 academic staff (0.4%). Here, the low number of editorial contacts in relation to the size of the university is typical for many of the more technical research areas covered by this institution as the average number of publications in peer reviewed journals in the engineering sciences is significantly less compared with, for example, the life sciences.

Table 50 presents *the topical* codes/themes where the topics emerging from the interview responses were coded with their underpinning assumptions or meanings.

Table 50: Topical codes and their underpinning assumptions

Topical code	**Underpinning assumptions**
Large scale investments	Facilities and infrastructure essential for the execution of research strategy in the sciences.
Increased labour force	Opportunities via more students and/or more research funding.
Focus on strengths	Improving current competencies leads to the achievement of critical mass with the available resources; *Focused Differentiation* (Porter, 1998, p. 39) is the common success strategy; the institute's administration to support strategy financially; profile building: the development of thematic focal areas; no one university can be the top of everything.
Governmental influence	Stimulation of research upgrading via e.g. *Excellence Initiatives* and Focal Area initiatives (Sonderforschungsbereiche); encouragement of profile building; opportunities for upgrading dependent on the government.
Strategy development	Externally: multilevel profile development initiatives through *Excellence Initiatives*, Rektorenkonferenz and Wissenschaftsrat; internally: stimulation not prescribed.
Benchmarking	Aim to find potential collaborators to build clusters; modification for local circumstances required; comparisons on sub-levels only.

Channels to publish	Establishment of a University Press or participation in editorial boards. Differences in publishing behaviour over the various research areas.
Institutional size	Size is largely a result of historical growth; size directly correlates with potential for upgrading and performance.
Presence of national research institute (e.g. Max Planck)	Offers additional thrust for upgrading.
Professionalising	High quality of grant and other funding applications leads to increased success rate.
Internal *linking*	Stimulation of interdisciplinary collaboration improves performance.

Elaborating on the essence of each code and its underlying assumptions resulted in the identification of 2 overarching themes and 9 main themes. Their relationship at this stage of competitive development is depicted in the *thematic map* presented in Figure 73.

Figure 70: Thematic map showing the two main themes in the investment-driven stage

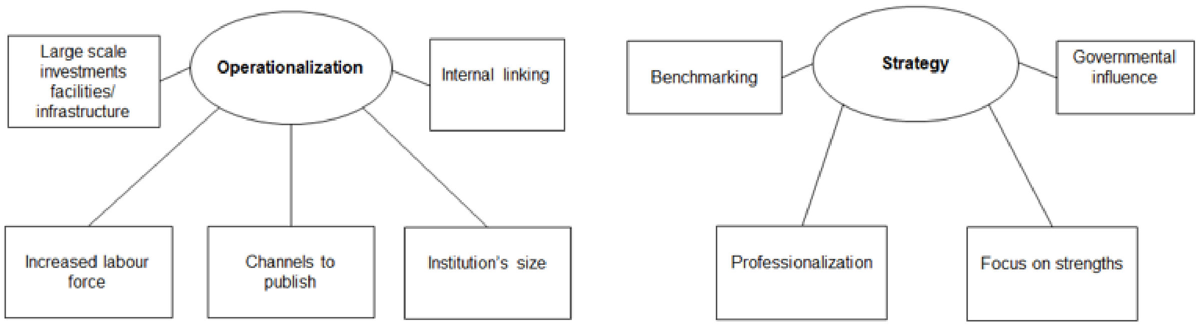


Figure 73 depicts the most prominent features of the *investment-driven* stage: operationalisation and strategy. The *best practice* for upgrading competitive strength appears to be rooted in benchmarking and focusing on existing research competencies. The government's role at this stage seems paradoxical since it encourages the upgrading of competitiveness in research via, for example, *Excellence Initiatives* or Focal areas initiatives

(Sonderforschungsbereiche), but also limits the opportunities for upgrading by not allowing universities to appoint tenured professors. Here, the internal professionalization of the research funding application process stimulates increased success rates.

4.3.3 The Innovation-Driven Stage

Interviewees were asked about: the role of collaboration for upgrading their research performance; the direction of the expansion of research areas; how upgrading was supported by the university itself and/or by the government; the development of the financial dependence of research departments.

The first interviewee indicated that internal collaboration at the university was becoming increasingly important. Being a textbook example of a *campus university* offered clear opportunities and advantages for internal collaboration. As regards international collaboration, the management of the university recognised that personal contacts were the key driver, but also that the instrument of international graduate schools was becoming increasingly important. The university had already founded an international graduate school with an American university, while two further international graduate schools were under development. Concerning possible differences between internal and international collaboration, the first interviewee believed that the geographical location of collaborators was becoming decreasingly important. This interviewee also maintained that there were historical focus areas at the university, for example medicine, but at this point in time one of the main objectives of the university was to foster interfaculty cooperation between the sciences and thereby enhance the university's research profile. For this purpose, a Strategic Research Fund was created focusing on Early Career Researchers and the establishment of research consortia. The first interviewee further highlighted how this university had established three so-called Focal area initiatives (Sonderforschungsbereiche), one in collaboration with two other universities. These Focal areas are supported by the German Research Foundation (DFG) with a volume of € 30 million. They were established for a period of up to 12 years and enabled researchers to pursue an outstanding research program, crossing the boundaries of disciplines, institutes, departments and faculties. Here, the first interviewee explained that this university was trying to make research less dependent on internal funding by increasing its external funding. Whereas this resulted in an increase in total income had the ratio of research funding to teaching income not changed much. The university did not monitor how many national grant proposals were submitted and only successful applications were registered. The success rate of grant proposals of this university with the DFG was estimated between 20 and 25%, this being about the national average.

The second interviewee made clear the considerations taken into account when expanding into new research areas and exploring the potential for cross-fertilisation:

"A research area has to be large enough in a way that you can define sub-areas … [because] with our size you cannot cover everything …What makes sense is to specialise, but of course not too much … because if you are too specialised you cannot follow innovation… You have to be able to follow the latest developments".

She pointed out how the regional government of Bavaria supported universities with new positions and extra funding if they had a chance to successfully participate in *Excellence Initiatives*:

"The regional government has a strong interest that as many Excellence Initiatives as possible are in Bavaria … But it is not only the Excellence Initiatives … there are a lot of programs at a national level to which the regional government is also giving money".

She elaborated on the upgrading of the competitiveness of research departments by presenting an example of a relative small research department which was in need of establishing a critical mass to become a Focal research area (*Sonderforschungsbereich)* and was supported by the university. In its support for upgrading, the university distinguished between departments which were already quite advanced and had a tradition of collaborative research and departments where the research was still done more individually. The university had encouraged the latter group through extra funding.

The third interviewee maintained that universities lacking an *Excellence* status were not recognised internationally. Because of this, the *Excellence initiatives* were crucial for the competitive strength of this university. He also confirmed that increased external research funding did not result in departments becoming less dependent on the university [similar was mentioned by the first interviewee] . Up to 50% of the total research costs of external funded research still needed to be financed by the university to cover the overheads. This interviewee was quoted as saying: “Every Euro research funding requires an additional 60 cents from the university”.

The fourth interviewee highlighted how the university had laid a matrix structure across all the faculties to create thematic research centres to foster interfaculty collaboration. International cooperation was also fostered via a program that included the appointment of visiting-professors and a focus on international experience when appointing tenured-professors. International collaboration was further facilitated with the creation of remote joint-institutes in Mumbai, Singapore, Cairo and Boston. For example, a joint research programme developed innovative technologies, future transportation concepts and the application of electric vehicles to match the challenging requirements of fast-growing tropical megacities. The fourth interviewee remarked on the joint-institute by saying:

“There is a joint campus where master and other programs are offered [and] out of which a research campus has crystallised … There are also professors from our university continuously in attendance who represent our institute internationally as a showcase project.”

The fourth interviewee acknowledged critical mass and internal competition as being key for portfolio development. She highlighted how in 2004 10% all the positions were taken away from the faculties and had to be (re-)captured in competition. The applications were assessed by external evaluators to select which of the applications had potential for the future On the selected themes she declared:

“Once a theme was identified and also fitted the policy of an entrepreneurial university, quite some money fled into the project to further foster this endeavour.”

The fourth interviewee maintained that the constant upgrading of the competitive condition played an important role at the university. For this purpose, an evaluation system was put in place where the faculties were regularly assessed on: how they presented themselves to the world; if there was an explicit research strategy; if the faculty benchmarked itself against other institutes; if the faculty's profile was reflected equally in teaching and research. This assessment was carried out by internal and external assessors and the outcome influences the future funding of the faculty. The fourth interviewee further believed that a strong university management was essential for the success of the upgrading process.

This interviewee also concurred with the other interviewees, declaring that universities in principle were inadequately funded, but that successful third-party funding could help to overcome this problem. She highlighted how the key success factors for attracting third-party funding were critical mass and an appropriate research profile. Remarking on critical mass, she declared:

"Key factors are student numbers, funding and built environment. It is of course the decision of a university how many students and how much growth are desired, but if a university wants to play a leading international role, a critical mass is essential. Such a role is determined by international demand and the university's strategy. International relevance is closely related to size of the university: only some small business schools manage to play a leading role despite their relative small size."

Table 51 presents the codes where the topics mentioned in response to the interview questions are coded with their underlying assumptions or meanings.

Table 51: Topical codes and their underpinning assumptions

Topical code	**Underpinning assumptions**
Size	A critical mass is essential for favourable scale effects.
Strong supporting departments	Offer the opportunity for exploring internal links, fostering interfaculty cooperation and benefitting from professional support.
Transcending departmental boundaries	The fostering of interfaculty cooperation enhances the research profile; setting-up of research consortia to establish a critical mass; focus on research cooperation.
International networks	Personal contacts are the drivers; the geographical location of collaborators is less important; International Graduate Schools can be instrumental to creating networks; Focus on research cooperation.
Vertical deepening and horizontal widening	The development of sufficiently large/not too large focal areas via the strategy of *Focused differentiation*.
Dependence on parent organisation	Large-scale national support for strong research areas (SFB) makes departments less dependent on parent organisation.

Elaborating on the essence of each code and its underlying assumptions resulted in the identification of one overarching theme and 4 main themes. Their relationship at this stage of competitive development is depicted in the *thematic map* presented in Figure 74.

Figure 71: Thematic map showing the main theme in the innovation-driven stage.

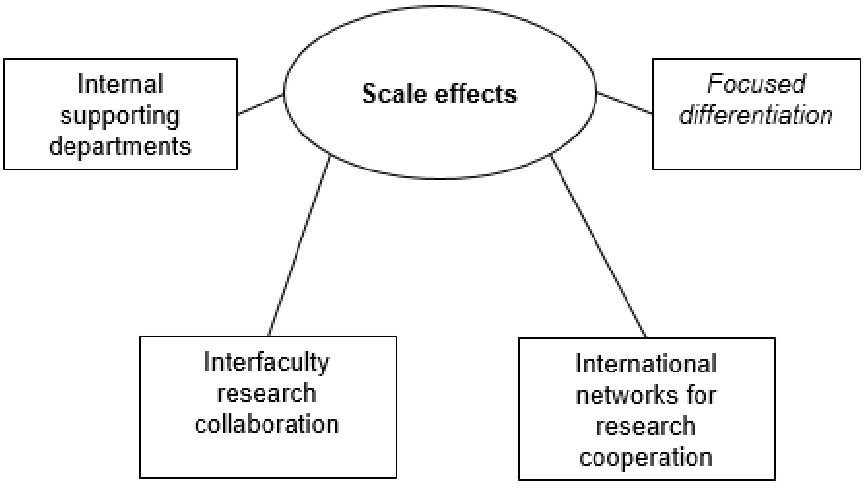


Figure 74 depicts the most salient features of the innovation-driven stage, this being characterised by scale effects, namely rooted in internal, interfaculty and international collaboration, and continuous upgrading of competitive strength via a *Focused differentiation* strategy leading to vertical deepening and horizontal widening.

4.3.4 The Genteel-decline stage

The interviewees were asked about a possible shift in emphasis from risk taking to stewardship; the existence of benefits from long-term investments; altering dependence on governmental support.

The second interviewee explained how the current strategy of c*onsolidation* was caused by declining student numbers after years of increase. The latter because of the reduction in the number of years spent in a gymnasium - from nine to eight years - and the abolishment of obligatory military service in Germany:

"To grow even more is now absolutely unrealistic for a regional university like ours. For big universities like Heidelberg, LMU [Ludwig-Maximilians-University of Munich], Technical University Munich, and Humboldt University Berlin there is a completely different situation … they are huge universities and in very

famous cities ... We have first of all to try not to lose our students … we have to be good enough to keep them and on top of this are we offering special master programs so that some extra students come to us."

In addition to the topic of the growth of research funding, she is quoted as saying:

"We still have a lot of potential … What was not explored so much in the past was the potential in the Arts and Humanities. That is where we will put our efforts."

The third interviewee commented on the current focus on stewardship:

"Nowadays, the university is pursuing a more defensive strategy: we aim to sustain our strengths. New research themes are encouraged but very cautiously. Our latest risky enterprise was the development of the research area Battery Research for about five years … We do not take risks lightly."

The current competitive research condition of this university is the result of investments from the previous years and the university is now consolidating this level. The opportunities for compensation by (non-) governmental project-based research funding are limited because of the unavoidable contribution by the university.

Table 52 presents the codes where the topics mentioned in response to the interview questions are coded with their underlying assumptions or meanings.

Table 52: Topical codes and their underlying assumptions

Topical code	**Underlying assumptions**
Stabilising / preserving	The foundation of growth (increasing student numbers) has been eroded; increasing governmental funding is unrealistic; industry research funding proves a limited alternative; unexplored potential in the Arts & Humanities

Elaborating on the essence of the *topical* code and its underlying assumptions has resulted in the identification of one overarching theme, 2 main themes and 4 sub--themes. Their relationship in this stage of competitive development is depicted in the *thematic map* presented in Figure 75.

Figure 72: Thematic map showing the main theme in the Genteel-decline stage

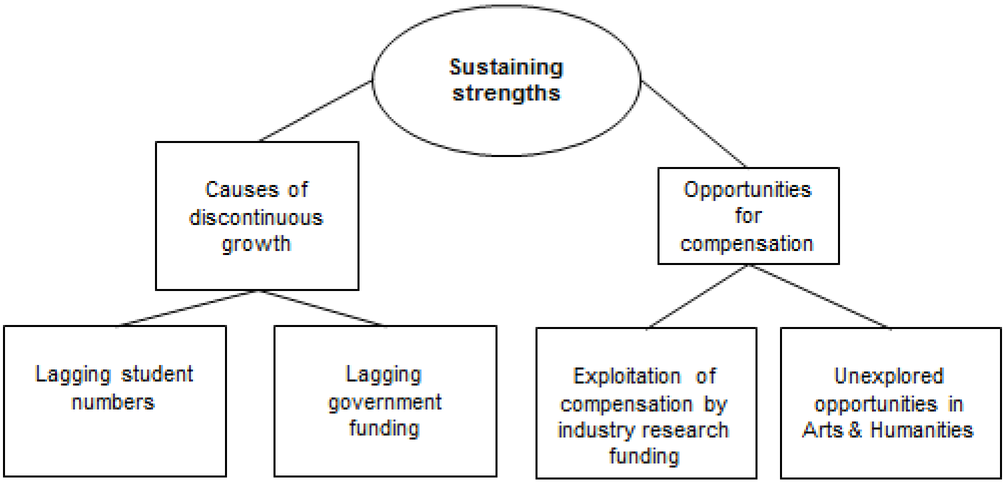
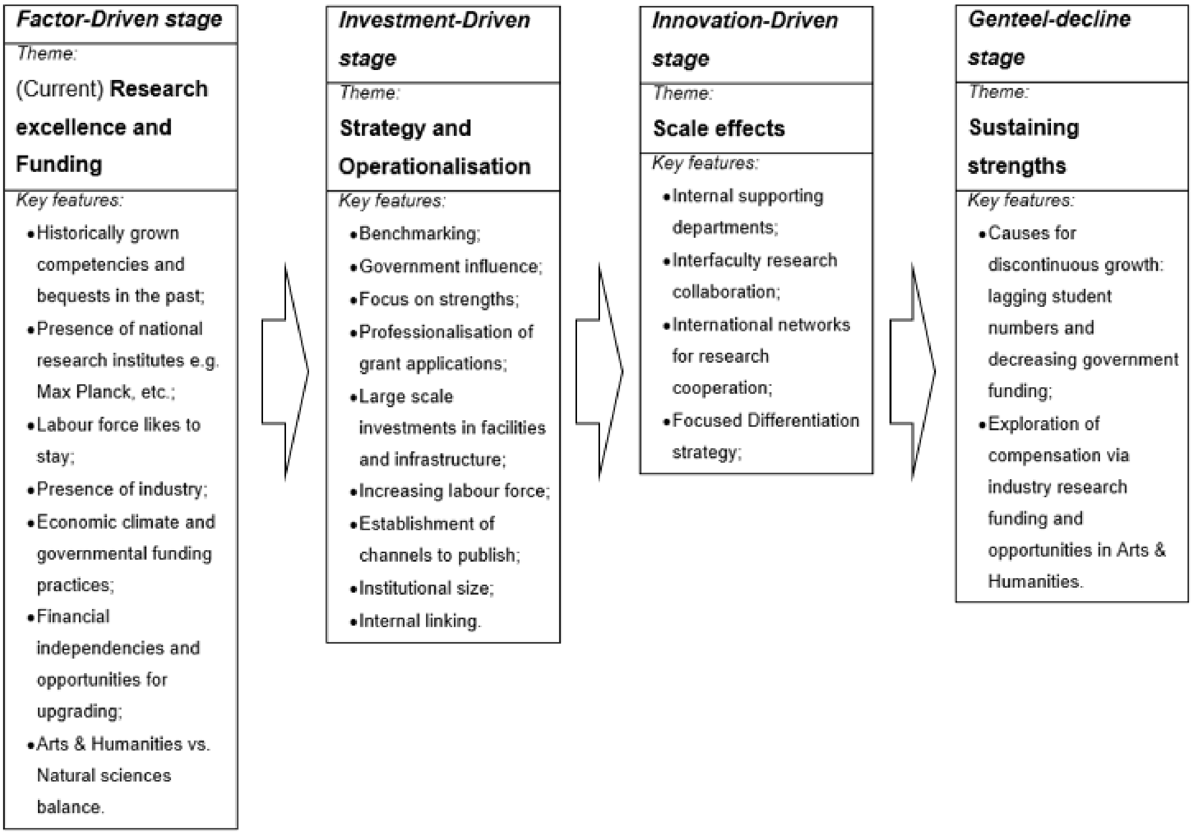


Figure 75 depicts the most prominent features of the *Genteel-decline* stage, this being characterised by a strategy of sustaining strengths. This is because previous growth has stopped due to the decline in student numbers and government funding. Compensation of the lagging funding is sought in increased industry funding and exploitation of opportunities in the Art & Humanities.

4.3.5 Concluding remarks

The aim of the semi-structured interviews in the present study was to gain a panoramic perspective of the dynamic process where university competitive advantage in research is created and upgrading is enabled. This is composed of a multitude of vantage points and multiple perceived realities, these being captured from the semi-structured interview data of which the most salient elements are presented in the Sections 4.3.1 to 4.3.4 of this chapter. A brief summary of the interview findings have been framed within Porter's four stages of competitive advantage model according to the ideas of Entmann (1993, p. 51) : 'The act of framing is thought to bring together insights and theories that would otherwise remain scattered' (Entman, 1993, p. 51). This is presented in Figure 76.

Figure 73:Themes and their most salient features of the four stages of competitive development in German higher education



The following discussion chapters develop the findings presented in this chapter in a more elaborate discussion, further exploring the concepts of the competitive strength of universities (Chapter 5) and the upgrading of research performance (Chapter 6).

CHAPTER 5: DISCUSSION, INTERPRETATION AND REFLECTION ON THE QUANTITATIVE FINDINGS

5.1 Introduction

Since the mid-eighties, performance measurement practices in the public sector have emerged alongside the rise of neoliberalism so that governmental sponsors started to view universities as corporate entities (Kuehn, 2002, p. 114). However, many studies investigating the measurement of university performance in research have been published, but very few have presented their findings within a broad framework embedded in management literature (Smulowitz, 2015, p. 71).

The pursuance of this under-researched area has led to the formulation of the following research question:

> *Can we employ a broad framework, well embedded in the management literature, that explains the impact of the determinants on university competitive advantage generated by research and helps to understand the dynamic process by which university competitive advantage generated by research is created and upgrading is enabled so that university policy makers' strategic objectives can be more effectively met?*

Drawing on this research question, the two main aims of this and the following chapter are as follows:

1. To identify the key determinants of research performance and to assess the impact of the independent institutional variables on research performance as a dependent variable;
2. To develop a dynamic model of university performance in research that reflects the characteristic sources of advantage and the nature and extent of success (This aim will be discussed in Chapter 6 of the thesis).

In pursuance of the main aims, the findings as presented in Chapter Four are further developed with the purpose of highlighting empirical evidence from the current study which supports or refutes the usefulness of Porter's diamond model in German higher education. This is done to assess the performance in the research of German universities, to (further) evaluate the existing theoretical base of Porter's model and other people's work on this topic, and to increase our understanding of the topic even more.

Having presented the data results from the collection of quantitative data for a sample of German universities in Chapter 4, this chapter is divided between the following sections for discussion:

- Section one comprises an introduction to this chapter and a preliminary review of Porter’s diamond model. (A more extensive review is presented in Section two of Chapter 6);
- Sections two to five discuss the determinants of each of the corners of the diamond as used in this study to assess the performance in research of German universities;
- Section six concludes with a summary of the chapter.

An exploration of the salient themes in this chapter and in the following chapter of this thesis is embedded in the existing literature, linking the contribution of the present study to knowledge and professional practice - the latter will be further developed in the final chapter of the thesis.

5.2 Key Determinants of the Corner Basic Conditions to Compete

To reflect the language of the higher education sector more appropriately in the present research, the corner *Factor conditions* of Porter’s diamond model has been renamed *Basic conditions to compete* (see also Section 2.4.3 and Section 4.2.4).

The key criterion by which the outcomes of the study of the *determinants* of the corner *Basic conditions to compete* are judged in the following discussion draws on the research question, namely is: “Do the outcomes of the present study explain the impact of the *determinants* on university competitive advantage generated by research and especially of the *determinants* of the corner *Basic conditions to compete*?”.

The *determinants* or *factors* which contribute to the condition of the corners of the diamond have been created by processes which are described in very broad terms and can be grouped in very broad categories, these include: human conditions, knowledge conditions, capital conditions and infrastructure conditions. Porter distinguishes between *Basic factors* such as location as well as passively inherited results of investments over time, and *Advanced factors* including highly educated personnel and university research institutes (Porter, 1998, pp. 74-77).The latter group of *factors* is most significant for competitive advantage.

The key question that arises when determining the condition of each of the four corners of the diamond is which *measures*[32] or *indicators*[33] to use. Here, the selection of the correct (number of) *measures* or *indicators* of the concept *performance* has proved to be difficult. A large number of studies highlighting the difficulties for finding adequate *measures* or *indicator*s can be found in performance measurement literature (Ridgway, 1956; Kaplan and Norton, 1992; Beamon, 1999, and more recent Luneva, 2015).

In an earlier study of the application of the diamond model in UK higher education, 8 *measures* or *indicators* are identified as being most relevant for the condition of the four corners of the model: (1) Log. teaching to research funding; (2) Total assets minus total liabilities; (3) the ratio of annual external income to research active academic staff; (4) the ratio of research students to research active academic staff; (5) the staff weighted grade of all the departments in an institution; (6) the percent of departments in the institution related to geography with an RAE grade of 5*; (7) the doctoral degrees awarded; (8) the ratio of journal articles to all the publications submitted (Curran, 2001, p. 243). From the present study emerged that not all these *measures* or *indicators* are available for German universities, and consequently, alternative *measures* or *indicators* have been used.

Curran's study identified (1) *Log. teaching to research funding;* (2) *Percent research income to total income*; (3) *Total income*; (4) *Library expenditure per student*; (5) *Total institutional grant*; (6) *Total assets minus total liabilities*; (7)

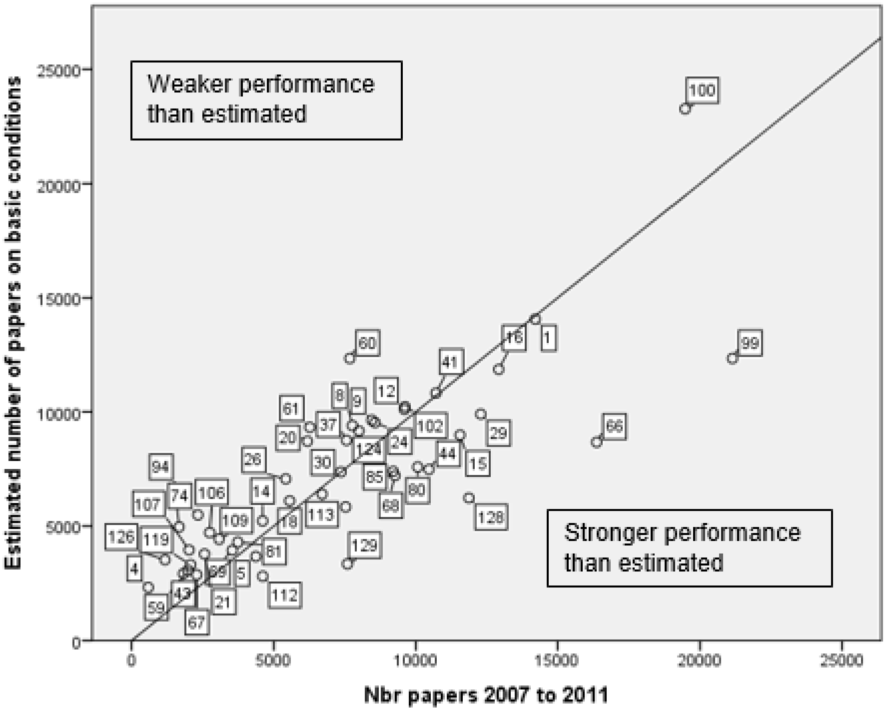
[32] Measures = quantities; "things that can be relatively unambiguously counted" (Bryman, 2012, p. 164)
[33] Indicator = "something that is devised or already exists and that is employed as though it were a measure of a concept" (Bryman, 2012, p. 164).

Percent endowment income and interest on investments to total income as key determinants[34] of the corner *Factor conditions* (Curran, 2001, p. 241). In the present study is the relationship between the variance in the - for German universities available - independent variables with the variance in research performance as dependent variable analysed. The - for German universities available - independent variables comprise: (1) *Total income*; (2) *Total teaching funding*; (3) *Total research funding* (4) *Total library expenditure*. The collective effect of these four variables on the condition of the corner *Basic conditions to compete* has been analysed via Multiple Linear Regression Analysis (MLRA). The results of this analysis show that two variables are the key determinants of the condition of that corner*: All income* and *Total library expenditure.* The results of the MLRA further show a degree of explained variance of 66.7% (R Square). The other two variables analysed are excluded in the cause of the analysis because their coefficients became non-significant as a result of the collective effects of the other variables.

The Multiple Regression Equation emerging from the MLRA: *Number of papers 2007 – 2011 = 78.044 + 191.544 (all income x ten million) + 209.177 (Total library expenditure x million),* makes it possible to estimate the condition of the corner *Basic conditions to compete*. Matching the estimated performances against the actual performances of all the universities in this study and depicting these in a scatterplot facilitates the identification of under-par (above the average line), on-par (around the average line) and above-par (below the average line) performing universities, these corresponding to weak, average and strong conditions of the corner *Basic conditions to compete,* as shown in Figures 77 (see Section 4.2.4 and Figure 57).

[34] Correlation coefficient (r) > 0.45 and significant at 1% level of confidence; having a moderate to large effect on the *research performance* of a university

Figure 74: Universities in the sample plotted according to the conditions of their *Basic conditions to compete* (Figure 77 is similar to Figure 57)



The discovery that financial determinants (*All income* and *Total library expenditure*) play a key role in shaping the *Basic conditions to compete* in German higher education is congruent with previous research in UK higher education. Curran (2001, p. 241) examined the correlation between 13 variables representing *factor conditions*, these ranging from the *Population of the city of the university* to the *Percent of total debt to the total income of a university*, and found that of these 13 variables only the aforementioned seven key determinants had a moderate to large effect on the *research performance* of a university; out of these seven variables, only three shared >33% (R Square) of their variance with the variance in *research performance*. These three key variables were all financial: *Log teaching to research funding; Total income*; *Percent research income to total income*. The investment in scholarship, measured by Curran by the variable *Library expenditure per student*, also had a large effect on *research performance* (R=0.52) but shared <33% (R Square) of its variance with the variance in *research performance*.

That financial measures play a pivotal role in performance measurement systems can be explained by the believe that the concept of performance measurement emerged alongside the development of double-entry bookkeeping (Neely, 2007, p. 144). Further were the performance reports used in the late 19th century by large scale corporations generated from accounting systems and these practices have changed little in the following hundred years (Kaplan, 1984, pp. 391-392).

Financial measures clearly offer advantages to university management when they lack the knowledge of and experience with specialised research departments. Interviewee two is quoted on this theme as saying: “I cannot decide what my colleagues for example in the law department are going to do …” This finding is congruent with findings from the private sector. Chandler (1990, p. 139) relates that top managers at corporate head offices increasingly rely on financial data because they are separated from their division’s middle management and often lack knowledge about and expertise with diversified divisions. Eccles (1991, p. 136) asserts that the dominance of financial measures is because they are assumed to be uniform metrics which are comparable across divisions and companies around the globe. However, while there is a clear dominance of bibliometric measures (paper- and citation counts) in the majority of studies concerning performance measurement in higher education, there is an on-going discourse among bibliometricians (= practitioner of bibliometry; see Footnote 1 on page 1) with the aim of coming to a “global standard … that enable[s] institutional benchmarking, support[s] institutional decision making, and cover[s] the entire spectrum of research activities” (Snowball Metrics, 2012).

The pivotal role of *Funding* emerging from the quantitative analysis in the present study is congruent with the qualitative results from the multiple field interviews, as presented in Section 4.3.1 and depicted in Figure 72 and further discussed in Chapter 6 of this thesis. This suggests that *Funding* plays a crucial role in the *factor-driven stage* whereby the financial condition of a university is on the whole determined by: (1) the nation’s economic climate and governmental funding practices; (2) the institution’s financial independence; (3) the balance between a focus on arts & humanities or natural sciences; (4) the presence of industry as an alternative funding source.

In contrast to *Basic factors* that are passively inherited, require *Advanced factors* - these being the most significant for competitive advantage - "… large and often sustained investments in both human and physical capital" (Porter, 1998, p. 77). Curran identified a number of *Advanced factor* conditions in UK higher education. He is quoted on this topic by saying:

> "… *Advanced factors* that had been created by investment over the years [comprise] the balance … between teaching and research … the investment in scholarship … the size of the institution and its financial strength, research orientation, degree of financial flexibility, and freedoms from the whims of government, the financial health and the degree of self-investment …"

Curran, 2001, p. 228.

Curran further highlights that two long-term institutional factors (1) *research orientation*; (2) *income*, influence the research performance of the institution Curran, 2001, p. 228.

The results discussed in this section of the chapter demonstrate that the condition of the corner *Basic conditions to compete* of German universities can realistically be estimated based on just two financial measures: *Total income* and *Total annual library expenditure.* Calculating the estimated performance of a university with these two measures and benchmarking the estimated performance with the actual performance makes it possible to identify the condition of this corner as under-par, on-par or above-par, where the condition of all four corners together shows the stage of the diamond / competitive condition of the university. The results presented in this section of the chapter demonstrate how all upgrading is rooted in *Funding* and *Investment in scholarship*. However, an important aspect to consider is the robustness of the available data – its timeliness, uniformity and correctness – this influencing the validity of the outcome of the assessment (see Section 3.4.1). Scarcer resources, increased accountability and increased competition make upgrading increasingly important for research managers, but also increasingly difficult. Thus, the easy identification of the condition of the corner *Basic conditions to compete* contributes to a better understanding of the determinants of university performance in research and offers research managers a starting point for their upgrading strategies.

5.3 Key Determinants of the Corner Ability Related Conditions to Compete

To reflect the language of the higher education sector more appropriately in the present research, the corner *Demand* conditions of Porter's diamond model has been renamed *Ability related conditions* (see also Section 2.4.3 and Section 4.2.4)*.*

The key criterion by which the outcomes of this study of the *determinants* of the corner *Ability related conditions* are judged draws on the research question, namely: "Do the outcomes of the present study explain the impact of the *determinants* on university competitive advantage generated by research and especially of the *determinants* of the corner *Ability related conditions*?".

In UK higher education, the indicators of the corner *Demand conditions* are the "… measures of demand by the academy for a department's research" (Curran, 2001, p. 232) and these are measured by: (1) indicators for the ability to publish; (2) indicators for the ability to secure research income; (3) indicators for the ability to support and attract people (Curran, 2001, p. 232).

The importance of (1) *Demand conditions* and (2) *Ability related conditions,* respectively as drivers of the upgrading of competitive advantage, both in the (1) private sector and in (2) the higher education sector respectively can be seen from the following two quotes: (1) "It shapes the rate and character of improvement and innovation by a nation's firms" (Porter, 1998, p. 86); and (2) "The RAE panel was widely believed to have placed great emphasis on demand conditions" (Curran, 2001, p. 232) respectively. In most studies about performance measurement in the higher education sector, the demand by the academy for departmental research was measured by the two most commonly used bibliometric measures: (1) *Number of papers published*; (2) *Number of times cited.*

To reflect the relationship of the *indicators* with the *abilities* related to this corner of the diamond in this study, the *Ability to publish* was measured using two indicators: (1) the *Ratio papers to all staff*; (2) the *Ratio papers to academic staff.* Here, the *Ability to secure research income* was measured by two indicators: (1) the *Ratio research income to all staff*; (2) the *Ratio total income to all staff*, while the *Ability to support and attract people* was measured by one indicator: (1) the Ratio non-academic staff to academic staff.

The Multiple Regression Equation emerging from the MLRA for the corner *Ability related conditions* was: *Number of papers 2007 – 2011 = 6,577.869 + 3,042.590 (*the *Ratio papers to all staff)* – 686.444 *(*the *Ratio total income to all staff).* The Multiple Regression Equation facilitated an estimation of the condition of the corner *Ability related conditions*. Here, matching the estimated performances against the actual performances of all the universities in this study and depicting these in a scatterplot, made it possible to identify under-par (above the average line), on-par (around the average line) and above-par (below the average line) performing universities, these corresponding with the weak, average and strong conditions of the corner *Ability related conditions,* as shown in the Figures 78 and 79 (see Section 4.2.4 and Figure 60) .

Figure 75: Universities in the sample plotted by the condition of their Ability related conditions (Figure 78 is similar to Figure 60).

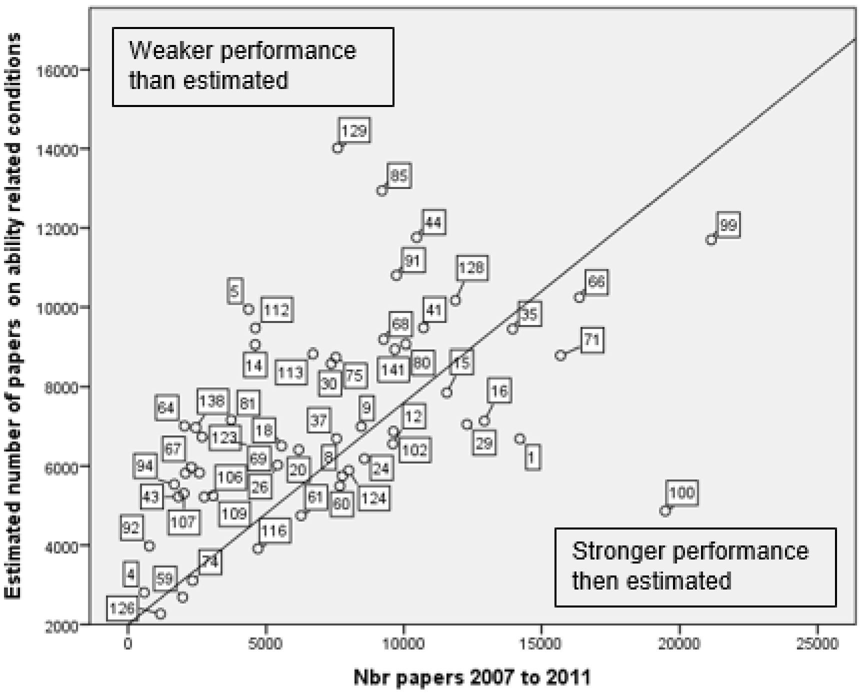
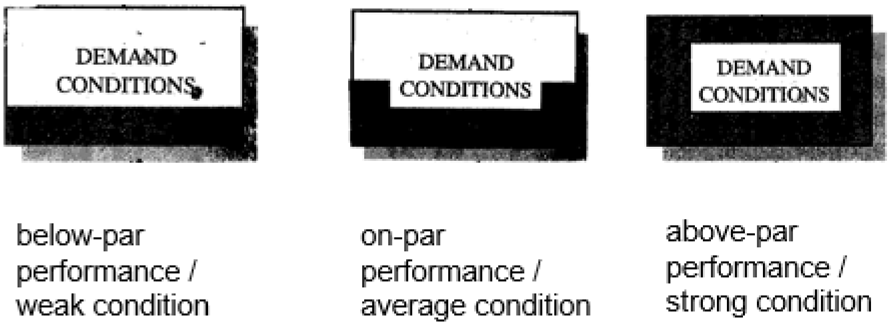


Figure 76: Depiction of the various conditions of the corner Demand conditions

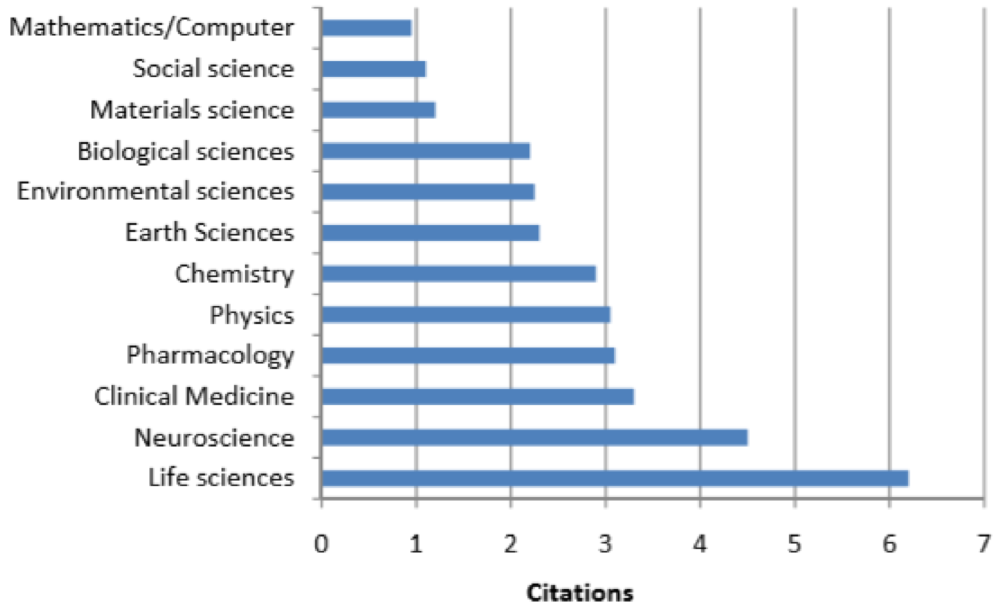


Porter, 1998, pp. 550, 553 and 558.

The regression equation reflects how in German higher education the condition of this corner can be estimated by the *ability to generate research income* and by the *ability to publish* - both abilities draw on the demand for the university's research. These findings are in part congruent with findings from earlier research into UK higher education where the condition of the corner *Demand conditions* could be estimated based on (1) the institute's *ability to generate income* as expressed by the *Ratio of annual external income to research active academic staff,* (2) by the *ability to attract and support staff being* expressed by the *Ratio of research students to research active academic staff* (Curran, 2001, p. 243). It should be noted here that the effect of the corner *Demand conditions* on the full diamond as found in UK higher education, this sharing 68% of their variance (R Square) (Curran, 2001, p. 243), was much larger than the effect of *Ability related conditions* on the full diamond as found in Germany's higher education, the latter sharing only 28% of their variance (R Square). A number of possible causes for the differences in the universities' *Ability to publish* emerging from Section 4. 3 of this thesis included:

1. Differences in publishing behaviour in the various disciplines, as shown in Figure 80 – Technical universities tend to publish less than the equivalent of fully-fledged universities;

Figure 77: Average citation rate per article in a number of disciplines



Adler, R., Ewing, J. and Taylor, P. , 2008, p. 8.

2. The presence of editors – universities tend not to have a clear strategy of access to channels in order to publish (see Section 4.3.2);
3. Links with national research institutes – collaboration with world-leading national research institutes, for example Max Planck Institutes, tends to propel publishing (see Section 4.3.1) ;
4. Being present in relative large segments and in segments that have been ignored by others – these segments tend to offer favourable opportunities (Porter, 1998, p. 550);

There are a number of possible causes for the differences in universities' *Ability to attract and support students and staff* emerging from Section 4. 3 of this thesis. including:

1. The presence of industry - offering job opportunities to postgraduates (interviewee 2);
2. A pleasant living environment (Interviewee 2);

3. Flourishing national economic conditions - offering favourable working conditions and grant opportunities (interviewee 2);
4. The university's willingness to heavily invest in skilled workers in order to pursue a research strategy (All interviewees);
5. The use of collaboration as a tool to increase size (All interviewees);
6. Governmental limitations and restrictions (All interviewees);
7. The university administration's support of recruitment strategies (interviewee 2);
8. The creation of international graduate schools (interviewee 1).

It is therefore recommended that the aforementioned possible causes of differences in the abilities of universities to publish and attract students as well as staff between Germany and the UK should be examined in more detail in future research.

Pivotal in the relationship between each of the three identified key indicators of the corner *Ability related conditions* and *performance* is the *direction* of the relationship. This issue is captured by the question "which comes first" and is characteristic for a *chicken-or-the-egg* causality dilemma. Compared with elite universities do researchers at universities with a modest performance in research often experience greater difficulty to: (1) generate income; (2) get published; (3) attract star-students and star-staff. Here, these difficulties are not shaped by the capabilities of the researchers at non-elite universities, but by a centre-periphery pattern which keeps actors at the periphery of the centre (Schubert and Sooryamoorthy, 2010, p. 183; see also Section 5.4).

In summarising this section of the chapter, it can be concluded that the basis of the *Ability related conditions* corner of the diamond is the *demand* for a university's research. The determinants of this corner are the *Ability to publish* and the *Ability to generate income* which can be measured using the indicators of the *Ratio papers to all staff* and the *Ratio total income to all staff*. This study further demonstrates that although these two indicators together have a significant relationship with university performance in research they have only a moderate effect on performance in research.

This finding is in contrast with previous research in UK higher education, which assumed that this corner would have a much larger effect on university performance in research. The findings of this study, however, explain the moderate effect of the *Ability related conditions* corner of the diamond on performance because of the omission of great differences in the ability of the research staff of German universities (see Section 4.3.2). This may differ in other countries and hence further research on this topic is recommended.

The performance of a university on this corner can be estimated by the Multiple Regression Equation (MRE) emerging from the Multiple Linear Regression Analysis comprising the aforementioned two indicators. Using the Multiple Regression Equation to estimate the performance of a university for this corner, and comparing the estimated condition of this corner with the actual condition, makes it possible to classify the condition of this corner as below-par, on-par or above-par. This contributes to the identification of the condition of the whole diamond / competitive condition of the university and creates a better understanding of the determinants of university performance in research thereby offering research managers a starting point for their upgrading strategies.

5.4 Key Determinants of the Corner Collaborator and Role Model Conditions

To reflect the language of the higher education sector more appropriately in the present research, the corner *Related and supporting industries* of Porter's diamond model has been renamed *Collaborator and role model conditions* (see also Section 2.4.3 and Section 4.2.4).

The key criterion whereby the outcomes of this study of the *determinants* of the corner *Collaborator and role model conditions* are judged in the following discussion are similar to the previous sections of this chapter and draws on the research question: “Do the outcomes of the present study explain the impact of the *determinants* on university competitive advantage generated by research and especially of the *determinants* of the corner *Collaborator and role model conditions*?”.

The corner *Collaborator and role model conditions* represent successfully related research departments which can function as collaborators or role models. Collaborators and role models play an important role in universities since they are a multiple source for potential advantage. Their role comprises: (1) helping to perceive new methods and opportunities to apply new technology; (2) exchanging R&D and carrying out joint problem solving leading to faster and more efficient solutions; (3) being a channel for transmitting information and innovations. In the private sector, proximity and cultural similarity are essential for competitive advantage, these being drawn from the *linkages* between *Related and supporting industries*. Such links are largest when the collaborating industries themselves are internationally successful (Porter, 1998, pp. 103-104). Applied for the higher education sector, Porter’s proposition suggests that the largest advantages are generated from collaborations with internationally successful universities that are in close proximity and which share a cultural similarity.

This proposition has been proved by bibliographic evidence from Germany’s largest universities: the Munich based Ludwig-Maximilians-University’s largest collaborator is the Technical University of Munich, jointly they published 3,345 publications. Berlin’s largest university, the Free University, shares most of its publications with the Charité Medical University of Berlin; jointly they published 1,581 papers (Scopus, no date).

The collaboration of internationally successful universities with equally successful collaborators within close proximity is shaped by a centre-periphery pattern. This centre-periphery pattern draws on the concept of *marginality* which keeps actors at the periphery away from the centre. For example, *marginality* may emerge as the “… inability of peripheral research groups to embed their research agenda in the larger scientific community” (Schubert and Sooryamoorthy, 2010, p. 183). The centre-periphery pattern draws on

Immanuel Wallerstein's *The Modern World-System* theory, dividing the world into *core states* and a *peripheral area* where:

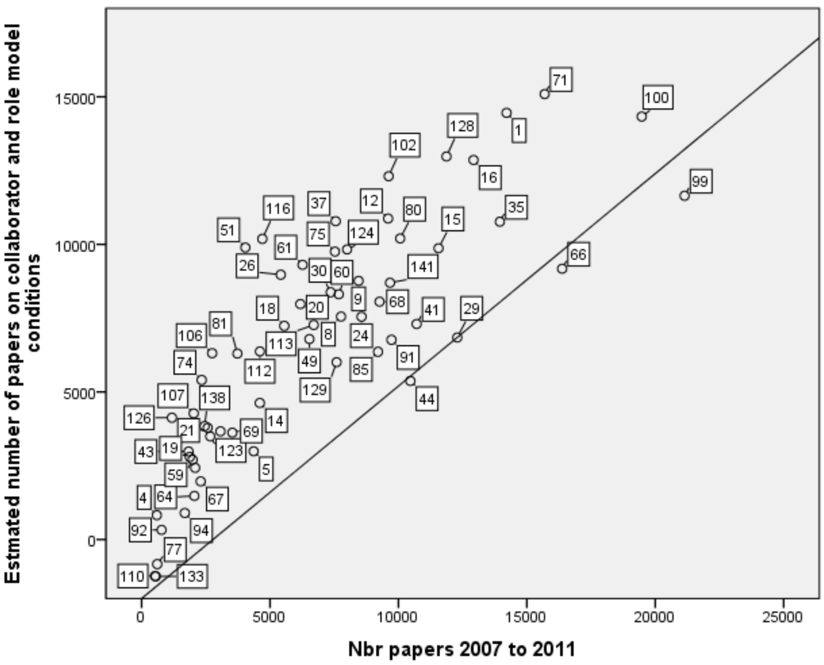
> *"The division of a world-economy involves a hierarchy of occupational tasks, in which tasks requiring higher levels of skill and greater capitalization are reserved for higher-ranking areas … the geographic maldistrbution of these occupational skills involves a strong trend toward self-maintenance. The forces of the marketplace reinforce them … the ongoing process of world-economy tends to expand the economic and social gaps among its varying areas in the very process of its development.*

Wallerstein, 1976, p. 230.

The use of similar indicators for this corner as used in earlier research in UK higher education proved impossible. Of the four out of six indicators tested in UK higher education to represent *related and supporting departments* with correlation coefficients between 0.70 and 0.82 (these being significant at 1% and R^2>0.33) (Curran, 2001, p. 242), only the indicator *Percent research active academic staff* had a close equivalent available in German higher education. This because three out of these four indicators had a relationship with the RAE grade, which was not applicable for German universities.

The results of the Multiple Linear Regression Analysis for the two determinants of the corner Collaborator *and role model conditions* tested in the present research, *Number of academic staff* and *SciVal subject areas* (see Section 2.4.2), showed a large amount of explained variance of 67.6 % (R Square), this indicating a large contribution of this corner to the full diamond. The Multiple Regression Equation emerging from the Multiple Linear Regression Analysis for the two determinants of the corner *Collaborator and role model conditions* was: the *Number of papers 2007 – 2011* = - 4,180.182 + 198.161 *(Academic staff x 100)* + 388.172 *(SciVal Subject Areas).* The Multiple Regression Equation made it possible to estimate the condition of the corner *Collaborator and role model conditions*. Here, matching the estimated performances against the actual performances of all the universities in this study and depicting these in a scatterplot facilitated an identification of under-par (above the average line), on-par (around the average line) and above-par (below the average line) for the performing universities, these corresponding with weak, average and strong conditions for the corner *Collaborator and role model conditions,* as shown in Figure 81.

Figure 78: Universities in the sample plotted by their Collaborator and role model conditions (Figure 81 is similar to Figure 63)



Earlier research in UK higher education confirmed that the presence of related and successful research departments had a connection with performance - the latter expressed by the RAE grade - although the relationship appeared to be stronger for the lower performing research departments (Curran, 2001, p. 232). A plausible explanation for the finding that having a larger research staff and being key in more research areas has a relationship with performance is that these circumstances offer greater opportunities for *Linkages* between successful research departments. Porter's (1985, p. 48) defines *Linkages* as "… relationships between the way one … activity is performed and the … performance of another" and this describes very appropriately the dynamics between collaborating successful research departments.

Opportunities for *Linkages* can be identified by examining how research activities affect or are affecting others, whereby *Linkages* can be found or created between research departments within the university but also between research departments at different universities (derived from Porter, 1985, pp.

50-51). Based on this proposition, the increase in the number of authors (= number of international collaborators) per paper can be attributed to an increased quest for *Linkages*. Such *Linkages* between successful research departments may be identified by examining how the research of one department influences the performance of another department within the institution, or how research at one institution influences research at another. Here, proximity and cultural similarity play an essential role with *Linkages.*

To sum up this section of the chapter, it can be concluded that the two key determinants of the corner *Collaborator and role model conditions* are: (1) *the Number of academic staff;* (2) *the Number of SciVal Subject Areas.* These two key determinants have an extensive effect on performance in the research of an institution, where a larger staff and a broader research profile offer greater opportunities for creating *Linkages* with international successful collaborators and role models. Upgrading competitive advantages via *Linkages* comes from (1) perceiving new methods and the opportunities of new technology in a more efficient way; (2) an improved exchange of R&D and joint problem solving; (3) a superior exchange of information and innovation. Thus, the easy identification of the condition of the corner *Collaborator and role model conditions* with help of the two key indicators contributes to a better understanding of the determinants of university performance in research and offers research managers a starting point for their upgrading strategies.

5.5 Key Determinants of the Corner Strategy, Structure and Rivalry Conditions

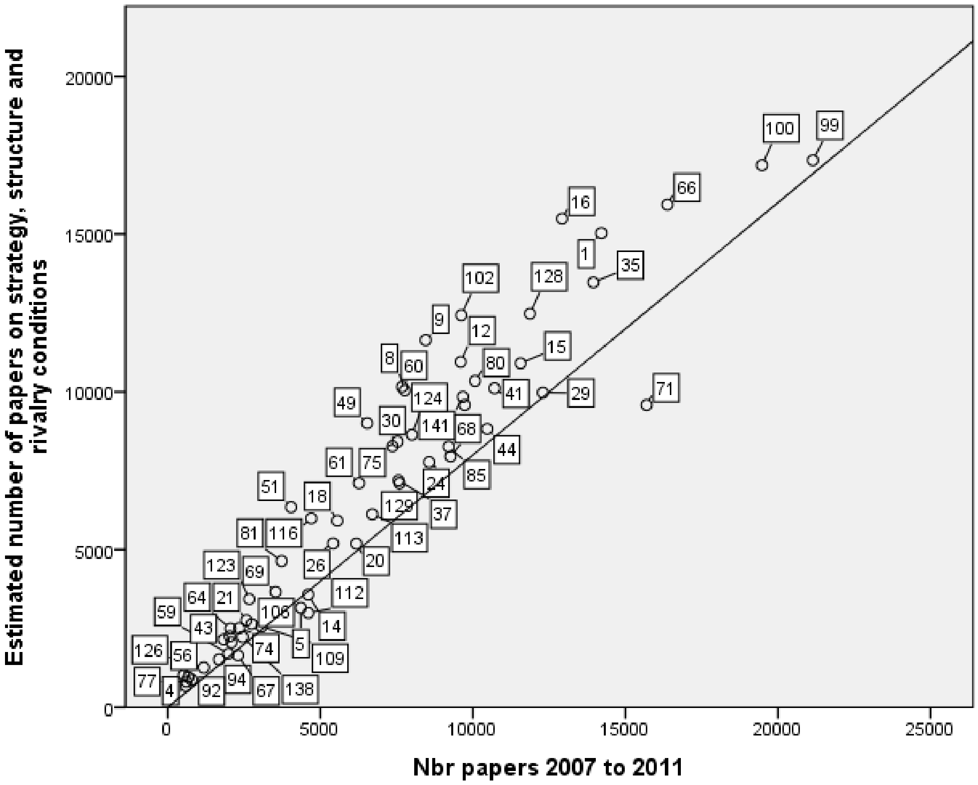
To reflect the language of the higher education sector more appropriately in the present research, the corner *Firm strategy, structure and rivalry* of Porter’s diamond model has been renamed *Strategy, structure and rivalry conditions* (see also Section 2.4.3 and Section 4.2.4).

The key criterion whereby the outcomes of this study of the *determinants* of the corner *Strategy, structure and rivalry conditions* are judged in the following discussion is similar to the previous sections of this chapter and draws on the research question: “Do the outcomes of the present study explain the impact of the *determinants* on university competitive advantage generated by research especially of the *determinants* of the corner *Strategy, structure and rivalry conditions* ?”.

In Porter’s diamond model the determinants of the corner *Firm strategy, structure and rivalry* govern how organisations are ordered and managed, as well as the nature of rivalry (Porter, 1998, p. 71). A total of eleven measures for this corner were tested in UK higher education in terms of their relationship with performance in research; this identified four measures with correlation coefficients (r) between 0.62 and 0.77 (with R Square >0.33, and sig. at 1%). These four measures were: (1) the *Number of academic staff* (r=0.62); (2) the *Ratio research support staff etc. to research active academic staff* (r=0.73); (3) *Doctoral degrees awarded* (r=0.77); (4) *Academic staff with > 10 citations per year* (r=0.73) (Curran, 2001, p. 242).

Drawing on Curran’s study, in the present research is the relationship in variance of the following independent variables: *Total authors, Total staff, Total non-academic staff* and *Total doctoral degrees awarded*, with the variance in the dependent variable - *research performance* - analysed. The collective effect of these four variables on the condition of the corner *Strategy, structure and rivalry conditions* was analysed via Multiple Linear Regression Analysis (MLRA). The results of the analysis showed that two variables were the key determinants of the condition of the corner*: Total authors* and *All staff.* The results of the MLRA further showed an explained variance of 88.3% (R Square), this being the strongest relationship of all the four corners with the performance in research. The other two variables analysed were excluded in the cause of the analysis because their coefficients became non-significant as a result of the collective effects of the other variables. The Multiple Regression Equation emerging from the MLRA for the corner *Strategy, structure and rivalry conditions* was: the *Number of papers 2007 – 2011 = -10.752 + 640.040* (*Total authors* x 1,000*)* + 56.001 (*All staff* x 1,000*).* The Multiple Regression Equation made it possible to estimate the condition of the corner *Strategy, structure and rivalry conditions*. Matching the estimated performances against the actual performances of all universities in this study and depicting these in a scatterplot, facilitated an identification of under-par (above the average line), on-par (around the average line) and above-par (below the average line) performing universities, these corresponding with the weak, average and strong conditions of the corner *Strategy, structure and rivalry conditions,* as shown in Figure 82.

Figure 79: Universities in the sample plotted according to their Strategy, structure and rivalry conditions (Figure 82 is similar to Figure 66)

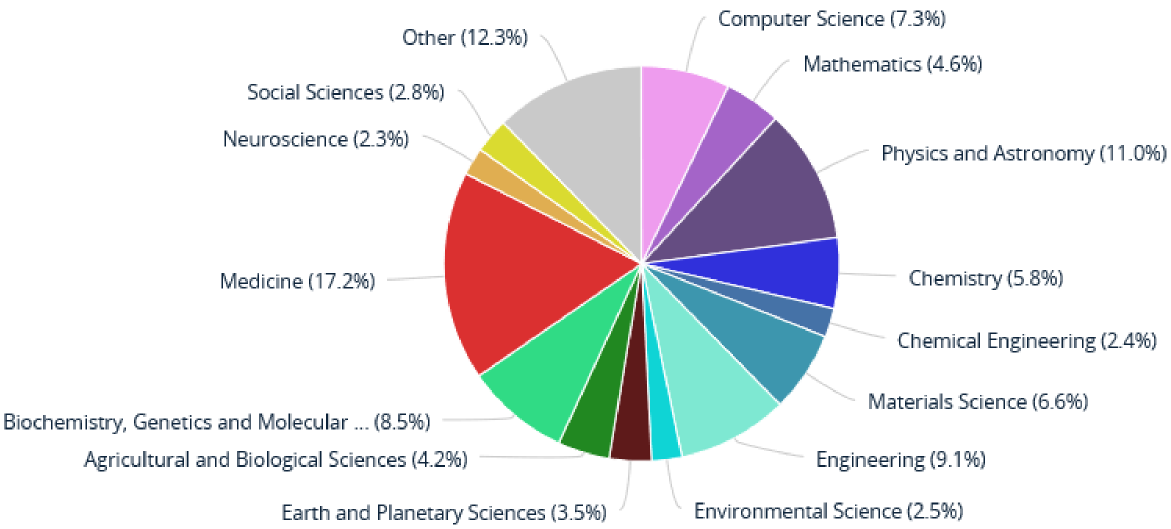


In addition to the two identified key quantitative determinants of the corner *Strategy, structure and rivalry conditions,* there are many qualitative aspects relating to how universities are organised or managed and how rivalry is perceived which influence performance in research. Among the most important qualitative aspects to consider are: (1) *interpersonal interactions* - governing attitudes towards management authority and collaborators; (2) *professionalism and key competencies* - influencing in which disciplines greatest success is achieved; (3) a *willingness to compete globally* - this being in part a function of perceived rivalry and in part a function of language skills; (4) *government policy* - here influencing the pressure on universities to internationalise; (5) *goals* - most strongly determined by national and federal governmental policies and social values of university staff; (6) *domestic rivalry* - nurturing ‘national champions' with an appropriate scale and strength to compete globally (adapted from Porter, 1998, pp. 109-110)

Attitudes towards management authority in the context of German universities are noticeable by any observer and are influenced by hierarchical and bureaucratic organisation as well as management practices - these being in contrast to the democratic nature of many university bodies such as the Senate. The members of the Senate, the major decision-making body of a university, are the deans (*Dekane*) of the various faculties, professors, academic and non-academic staff and students; it is their job to make democratic decisions about such aspects as the annual budget.

As a consequence of Germany's hierarchical and bureaucratic culture is at German university departments success highest in those research areas where competitive advantage is rooted in a strong inclination towards methodological procedures and approaches and is most *professionalism and key competencies* found in research areas with a highly technical or engineering content (adapted from Porter, 1998, p. 108). This phenomenon is confirmed by the following breakdown of the work of German researchers: 32% is found in the natural sciences and mathematics, 29% in humanities and social sciences, 22% in engineering sciences, 15% in medical science and 3% in agricultural sciences (Research in Germany, 2014). The strong inclination towards natural and medical sciences also emerged from an analysis of the publications by German authors according to journal category, this being depicted in Figure 83.

Figure 80: Analysis of publications by German authors according to journal category



SciVal, no date.

The *Willingness to compete globally* at German universities is in part a function of the research areas where they create a competitive advantage and in part a function of the existing language skills and attitudes towards writing in a foreign (English) language.

With regards to the research areas where German researchers create a competitive advantage should be taken in account that knowledge workers in technical and engineering areas tend to be practical and solution-focused as well as being less interested in fundamental research. However, because the demand for fundamental research papers is significantly larger than for applied research papers, this tendency poses a disadvantage for many German researchers.

Regarding existing language skills and attitudes towards writing in a foreign (English) language, an added disadvantage for many German researchers is the German preference for the vernacular language, as is noticeable for example in dubbed English movies but also in the preference of German technicians and engineers to publish in German language journals. In addition, older researchers from the former German Democratic Republic, this being separated from 1949 until 1990 from the German Federal Republic have a deficit in the use of English as the language of modern science.

In addition, the nature of governmental governance has a large influence on the advantage of German universities. The major research funding agency in Germany is the German Research Foundation (DFG). The DFG uses competition to select the > 30,000 projects which receive > € 2.5 billion in funding annually. The higher success rate of funding applications by the DFG has negatively influenced the *willingness to compete internationally,* for example by the European Research Council (ERC) (interviewee 2, see Section 4.3.1). Further aspects of the nature of governmental governance affect the context in which German universities operate and limit their entrepreneurial freedom and opportunities for goal setting and creating advantage. For example, it is not the universities but the federal governments who decide on the appointment of new / additional professors and current funding practices in some federal states require an additional contribution from the university's budget to all third party funding (Interviewee 3). Consequently, the practice of having a clear strategy and goal setting is not widespread in German higher education. Interviewee three is quoted on this theme as saying: "… currently there is hardly any profile development at German universities". An additional reason for the omission of profile development is the greater autonomy of research departments in universities compared with those in the industry since the former do not have to align themselves with 'corporate' objectives (Ball and Butler, 2004, p. 89).

Earlier research analysing 73 public universities in Germany found that increased competition amongst German universities has led to a higher quality and quantity of academic research (Warning, 2004, p. 407). Further empirical evidence about the strength of national rivalry in science has been presented by Porter who states: "there are many examples where one nation achieved disproportionate international success for a period of time, often involving a group of .. scientists …who were working in the same city" (Porter, 1998, p. 121). Here, the identification of *domestic rivalry nurturing 'national champions'* is congruent with the findings of the present research, for example showing the Technical University of Munich and the Ludwig-Maximilian-University of Munich to be the two largest universities in Germany with an annual expenditure of €1.095 M and € 489 M respectively. Despite the advantages of rivalry and competition between universities, care should care be taken to encourage competition in such a way that the benefits of collaboration are not neglected (Orr, 2004, p. 360).

To summarise this section of the chapter, the key determinants of the corner *Strategy structure and rivalry conditions* - comprising how universities are organised and managed as well as the influence of rivalry – are *Total authors* and *All staff.* These two determinants have the largest effect on the performance in research of an institution in comparison with all the other determinants tested and discussed in this chapter. In addition to quantitative measures do many qualitative aspects also influence this corner. Some of the most important qualitative aspects are: attitudes towards management authority and collaborators (this encompassing the influence of hierarchical and bureaucratic organisation and practices); professionalism and key competencies (explaining the preference for research areas with highly technical and engineering content and a disinclination for fundamental research); the willingness to compete globally (this being driven by government funding opportunities and language skills); the role of governmental governance (determining entrepreneurial freedom and affecting goal setting as well as profile development); domestic rivalry (nurturing 'national champions' but also jeopardising collaboration). Thus, an examination of and discussion about the determinants of this corner provide a better understanding of their contribution to university advantages in research and to the condition of the corner *Strategy, structure and rivalry conditions.*

5.6 Summary of the Discussion of the Determinants of the Four Corners of the Diamond

The aim of the current study is to present a theoretical framework which explains why a university achieves a competitive advantage in all its forms. This makes it possible to understand why some universities perform better than others and also explains the environment in which the universities compete and strive to upgrade their performances (see Section 1.4). In particular, the aim of this chapter is to develop an understanding of the determinants (see footnote Section 4.1) of a university's competitive advantage in research.

To this end, this chapter discusses the empirical evidence that may support or refute the usefulness of Porter's diamond model in order to assess and understand the quality of university performance in research. The objectives in doing this are twofold: (1) to establish if Porter's diamond framework is applicable in higher education; (2) to develop an understanding of the determinants of a university's competitive advantage in research. Here, the context of the argument is also twofold: (1) many studies have been published about the measurement of university performance in research (especially in bibliometric literature), but these have ignored the performance measurement frameworks embedded in management literature; (2) the determinants of the condition of performance in research are numerous and make it necessary to extract the most salient determinants and organise these into a coherent pattern. The purpose of this is to understand the cause and effect relationships between determinants and performance and to avoid an information overflow.

In the present research, it was found that many of the indicators used in previous research in UK higher education (Curran, 2001) were not available for German universities; the main reason for this was because they were derived from RAE-data. These missing indicators made it necessary to find substitutes that were close to the attributes highlighted by Porter for each corner of his diamond model, or that closely resembled the indicators used in UK higher education. In this study, the 8 most salient indicators were selected from an initial set of 15 indicators via Multiple Linear Regression Analysis. A comparison of the outcomes from this analysis with the results from UK higher education, as shown in Table 53, reveals that similar indicators impact on performance in an almost identical way (an exception here being the *Ratio of total income to all staff* and the *Ratio of annual external income to research active academic staff*).

Table 53: Key indicators of research performance in Germany and their UK equivalents.

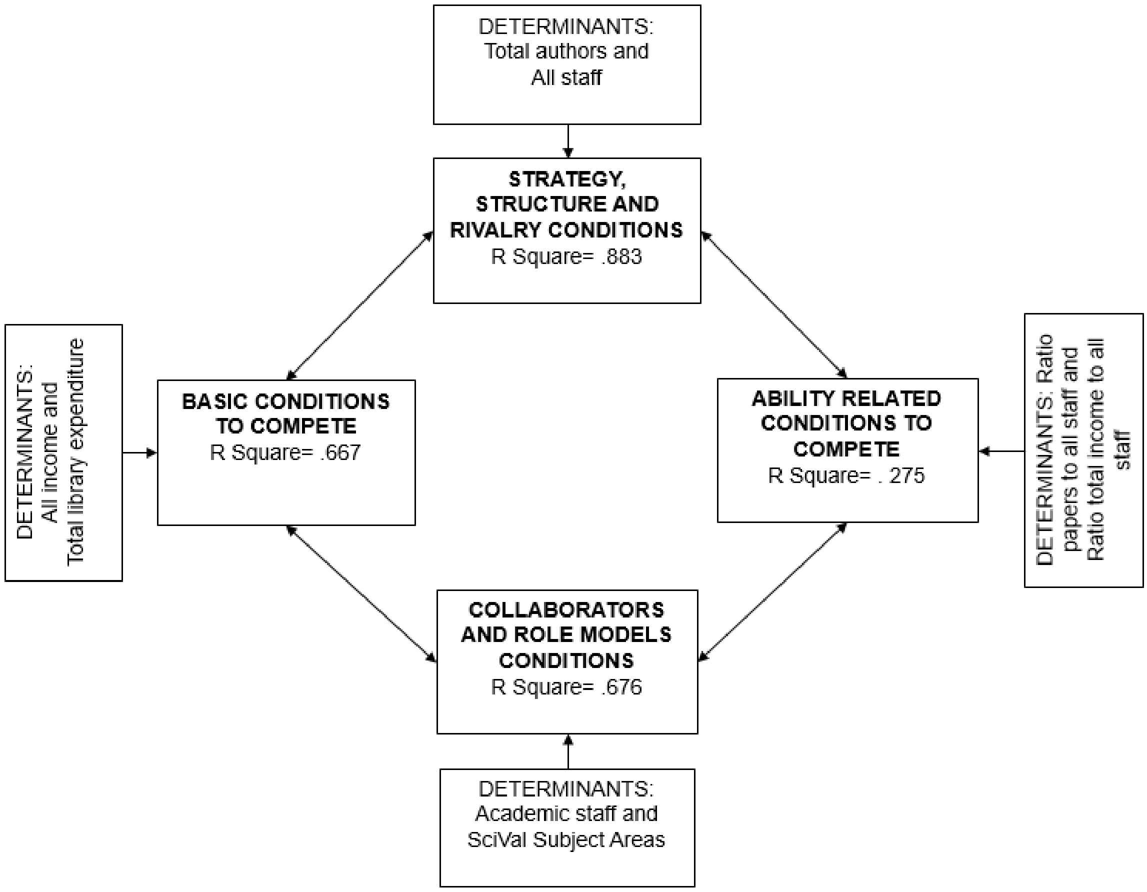
	Independent variable*	R	Independent variable**	R
1	Total income	0.78	Total income	0.61
2	Total library expenditure	0.49	Library expenditure per student	0.52
3	Ratio papers to all staff	0.44		
4	Ratio of total income to all staff	0.18	Ratio of annual external income to research active academic staff	0.71
5	Number of academic staff	0.77	Number of academic staff	0.62
6	Number of SciVal subject areas	0.70		
7	Number of authors	0.94	Citations	0.73
8	Number of university staff	0.83		

*the present research; **Curran, 2001.

The significance of this findings for the aims of the present research is threefold: (1) the findings demonstrate / confirm that Porter's diamond model, developed for the corporate sector, can be employed in the higher education sector; (2) on a broad level, the impact of similar indicators on performance is congruent with different countries; (3) on a narrow level the ranking of the indicators according to their impact on performance may differ. Here, a comparison of the findings of the present research with the findings in UK higher education indicates that the top two indicators for each corner in different countries have a close similarity and a similar impact on performance.

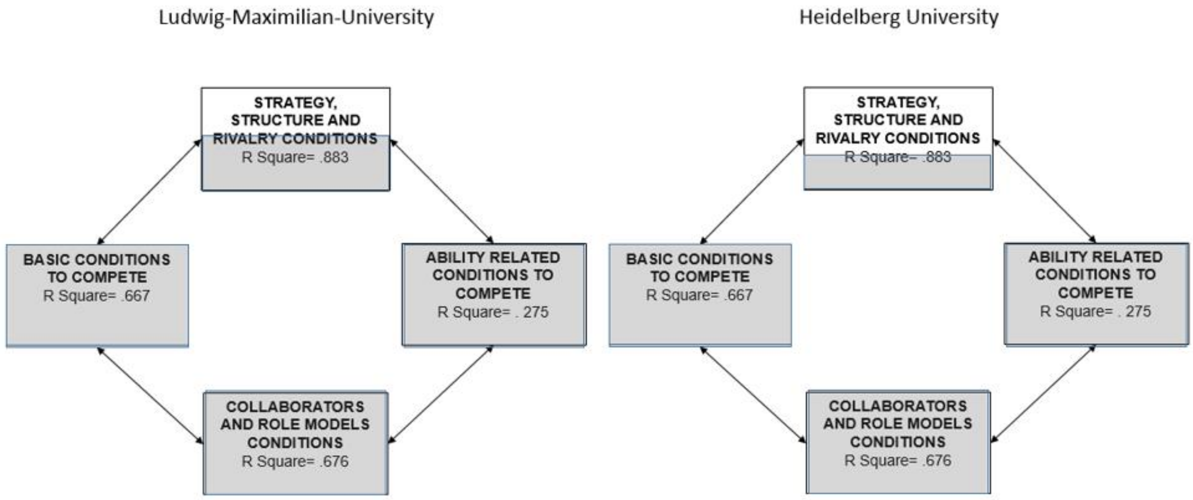
The impact on professional practice is that a country-specific and adapted version of Porter's diamond model provides university decision makers with a succinct overview of the competitive quality of a university by means of a few key determinants and this avoids an information overload. The Germany-specific adapted version of Porter's diamond is presented in Figure 84.

Figure 81: The for German higher education adapted version of Porter's diamond



The employment of this model to assess the quality of the diamonds of the Ludwig-Maximilians-University of Munich (#101) and of the University of Heidelberg (#67), both of which belong to Germany's elite research universities, is demonstrated in Figure 85. The condition of each corner of the diamonds is based on the position of the universities in Figures 57, 60, 63 and 66 in this chapter.

Figure 82: Condition of the diamonds of the Ludwig-Maximilians-University of Munich and of the University of Heidelberg.



As shown in Figure 85, both universities performed above-par in three out of the four corners, while the Ludwig-Maximillians-University scored on-par and the Heidelberg University scores somewhat below-par for the corner *Strategy, structure and rivalry conditions*. Thus, Figure 85 shows two almost full diamonds, with all the determinants working and their interactions at their strongest. This therefore appears to be a very plausible depiction of the competitive condition of these universities.

The only source of *bias* in this approach can be found in the visual interpretation of the performance - for example the question where exactly does *under-par* ends and *on-par* begins? Bearing this caveat in mind, the diamond model offers an almost bias-free method to assess the quality of performance in the research of German universities.

Porter's model is based on the following five assumptions of which two being related to the quantitative determinants discussed in this chapter: (1) international success is based on *Advanced factors*; (2) to achieve sustained competitive advantage, internationally successful organisations must operate in clusters with related organisations with strong diamonds. The other three assumptions which will be discussed in Chapter 6 of this thesis are as follows: (1) an organisation must have reached the *innovation-driven stage* to have achieved and to sustain the strongest competitive position; (2) the competitive position of a nation is determined by the performance of the organisations for which it is the home base; (3) outward foreign investment is a manifestation of competitive strength.

Porter (1998, p. 77) recognised highly educated personnel and university research institutes in sophisticated disciplines as *Advanced factors*, while Curran (2001, p. 228) highlighted the balance between teaching and research, the investment in scholarship and institutional variables such as size, research orientation, financial freedom and health as *Advanced factors*. Hence, the findings of this study showing that all the tested financial indicators have a very large effect on university performance in research and that investment in scholarship measured via *Annual library expenditur*e has a significant (if moderate) effect on performance support the assumption that international success is based on *Advanced* Factors.

The second assumption on which Porter's theory is based is that in order to achieve sustained competitive advantage, an internationally successful organisation must operate in clusters with related organisations that have strong diamonds. This is congruent with the results of the present study since it has been shown that the corner *Collaborator and role model conditions* has a very large effect on the performance of a university. In addition, the evidence in this chapter of intensive collaborations between universities in Berlin and Munich confirms the view that proximity and cultural similarity play a key role in collaboration. These findings suggest that within the context of this chapter, no weaknesses in the two assumptions of Porter can be found.

The discussion in this chapter further demonstrates how the evidence from this study is convincing and on the whole consistent with Porter's argumentation in his work 'The competitive advantage of nations' (Porter, 1998) and is congruent with earlier research successfully using the diamond model in UK higher education. Hence, the findings of this study demonstrate how the adapted version of Porter's diamond as presented in Figure 84 is applicable in German higher education, and how the adapted diamond model makes it possible to understand the role and effect of the determinants of university competitive advantage generated by research as well as offering a useful tool for university decision makers to help them achieve their strategic goals more effectively.

The adapted diamond model offers a solution that is compelling in its simplicity - competitive strength is assessed using only a few key determinants and the condition of each of the four broad attributes as expressed in under-par, on-par or above-par performance can easily be depicted using the four-corner model – and offers a succinct overview for the decision makers.

Questions arising from the discussion in this chapter and which will be discussed in the following chapter are as follows: (1) What basic forces propel upgrading?; (2) Which characteristic impediments to upgrading can be recognised?; (3) Is there a way of abstracting the upgrading process and a way in which to examine the development of upgrading?

CHAPTER 6: DISCUSSION, INTERPRETATION AND REFLECTION ON THE QUALITATIVE FINDINGS

6.1 Introduction

At the end of the previous chapter an adapted version of Porter's diamond model was presented to depict *snapshots* of the competitive condition generated by research of German universities. Such a *snapshot* however does not inform university decision makers about how the competitiveness generated by research develops, nor does it inform them about the characteristics of each stage of competitive development or the forces that propel upgrading. Therefore, the aim of this chapter is to present an adaptation of Porter's *Four stages of competitive development* model (Porter,1998, p. 546) which can be used in German higher education to abstract the stages of competitive development, to provide a framework for interpreting the qualitative findings presented in Chapter 4 of this thesis and to enhance an understanding of the dynamics of university competitiveness generated by research. This aim draws on the second element of the research question:

Can we employ a broad framework, well embedded in the management literature, that explains the impact of the determinants on university competitive advantage generated by research and helps to understand the dynamic process by which university competitive advantage generated by research is created and upgrading is enabled so that university policy makers' strategic objectives can be more effectively met?

In pursuance of this aim, the findings presented in Chapter 4 are developed further to highlight new ways of understanding this topic. The empirical evidence from multiple case studies are also drawn upon to evaluate the theoretical base of Porter's model and other work in this area, and to improve the understanding of the creation and upgrading of competitive advantage generated by research of German universities. The significance of the findings is described and interpreted in the context of the aim of this chapter and the gaps in the extant literature.

While the qualitative data results from the multiple case studies from a sample of German universities have been presented in Chapter 4, the discussion in this chapter is divided into the following sections:

Section 6.1: This section presents the introduction to this chapter, with a preliminary review of Porter's model of *Four stages of competitive development*;

Sections 6.2 – 6.5: These four sections provide discussions about the characteristic sources of advantage in each of the four stages of competitive development as they have emerged from the multiple case studies;

Section 6.6: This part includes a summary of Sections 6.2 – 6.5 and is followed by a presentation of an adapted version of Porter's *Four stages of competitive development* model;

Section 6.7: Here, a critical discussion of Porter's thesis is presented with a focus on its application in German higher education;

Section 6.8: This section provides a summary of the discussion of Porter's thesis.

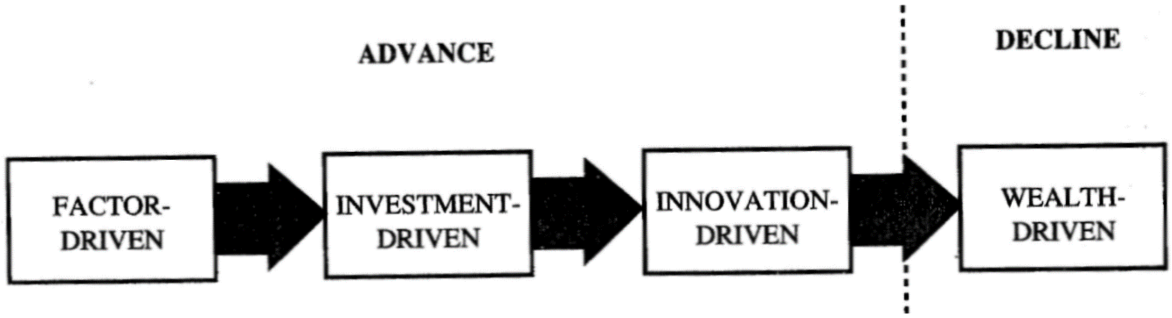
An exploration of the salient themes in this chapter is embedded in the existing literature and linked to the contribution of the present study to knowledge and professional practice, the latter two being further developed in the final chapter of this thesis.

It emerged during the interviews as well as in discussions concerning the preliminary results of this study that the approach and terminology of this study is unusual in higher education. This is congruent with previous research. For example, Porter highlights that the language he uses when describing his model is “deeply embedded in the language of economics” (Porter, 1998, p. 74) and maintains that this terminology may be awkward to some in another domain. Ball and Butler (2004, p. 88) also present some examples of the differences in the vocabularies of the private sector and of the higher education sector. It is therefore with the goal of better adhering to the language of the higher education sector that the *wealth-driven* stage of Porter’s model in the present research has been renamed *genteel-decline driven* stage.

The review of the literature as presented in Chapter 2 of this thesis comprises a selection of literature about the dynamics of the upgrading of competitive advantage and how upgrading progresses. In management literature, a competitive condition is described as being a function of the productivity with which resources are employed - where productivity is viewed as a function of the segments served and the nature of competitive advantage. Developments in the nature of competitive advantage involve a greater or lesser sophistication of skill levels (Porter, 1998, p. 544). Thus, the upgrading of competitiveness can be interpreted as an upgrading of the segments in which competition takes place and of the sophistication of the skill levels, this being a description well suited to the higher education sector.

Porter’s *Four stages of competitive developmen*t framework (Porter, 1998, p. 546), as shown in Figure 86, conceptualises the process of upgrading using four successive *stages of competitive* development: (1) the *factor-driven* stage; (2) the *investment-driven* stage; (3) the *innovation-driven* stage; (4) the *wealth-driven* stage. Here, successive upgrading takes place in the first three stages of competitive development, whereas the fourth stage is one of drift and ultimate decline.

Figure 83: (similar to Figure 67) The Four stages of competitive development



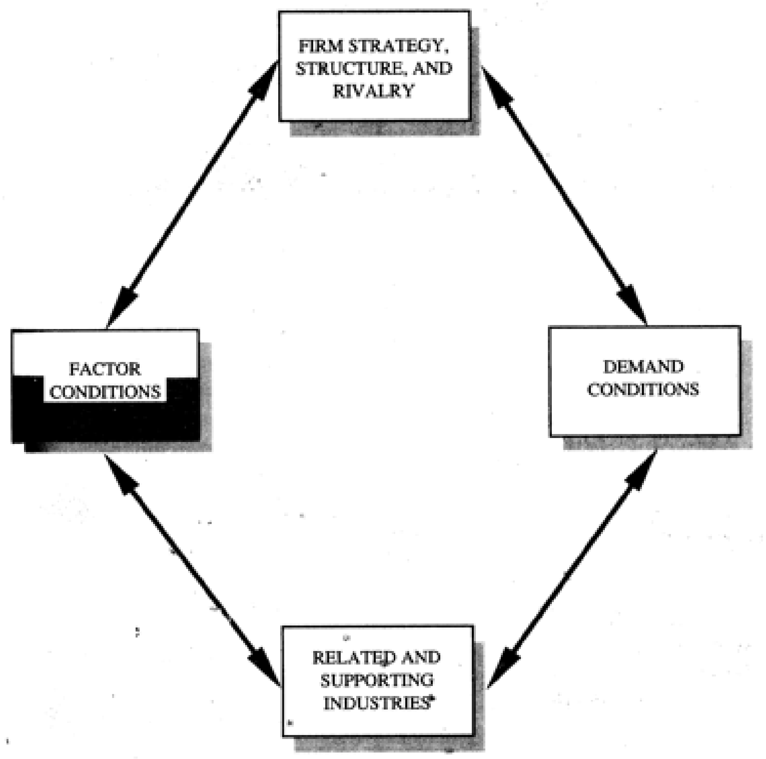
Porter, 1998, p. 546.

Porter (1998, p. 546) claims that the four stages of his model facilitate an understanding of how organisations grow, what the characteristic problems are and what forces propel upgrading. Therefore, the discussion in this chapter will focus on these three aspects. Significantly, Porter (1998, p. 545) highlights how his framework is a way of understanding the process of upgrading and it is not inevitable that all the stages will be passed through, nor will any particular situation fit a given stage exactly. However, bearing these caveats in mind, this framework has been chosen in this study as a suitable tool with the following aims: (1) to identify an emergent pattern in the nature of competitive advantage; (2) to reflect on the characteristic sources of advantage for each stage of competitive development; (3) to highlight the critical attributes of the competitive condition where the condition of the diamond reflects the stage of competitive development. Given the aforementioned caveats, the aim of the discussion here is to highlight the most important aspects of university competitive advantage as generated by research in each stage of competitive development.

6.2 The Factor-Driven Stage

Porter's thesis argues that in the diamonds of organisations in the *Factor-driven stage*, the corner *Factor conditions* (in the present study renamed as *Basic conditions to compete*) is the only source of advantage, as shown in Figure 87.

Figure 84: The factor-driven stage.



Porter, 1998, p. 547.

The relationships between the various aspects of the *factor-driven stage* as discussed in this section of the chapter are depicted in Figure 88.

Organisations at this stage of development in the corporate sector draw all their advantage from *Basic Factors* (natural resources and a semi-skilled labour pool) (Porter, 1998, p. 547) and they are vulnerable to a loss of factor advantage - for example, they are sensitive to economic fluctuations. Porter highlights the fact that all organisations at some point in time have been at this stage and only a few ever move beyond this stage (Porter, 1998, pp. 546-548).

Earlier research in UK higher education has found that the universities in the *factor-driven stage* were former polytechnics which did not receive research funding after 1992 as well as particular old universities with average or low RAE grades (Curran, 2001, p. 248). This finding suggests that the absence of upgrading is predominantly brought about by the lack of necessary funding to finance upgrading into more sophisticated segments or the upgrading of skill levels. Here, UK universities in the *factor-driven stage* draw what advantages they have from *Basic Factors* inherited or from the results of historical circumstance.

A number of characteristics of the *factor-driven stage* have emerged from the interviews in the multiple case studies. Interviewee one reported that the absence of bequests makes his university solely dependent on (governmental) sponsors and vulnerable to the effects of the economic downturn. This latter has come about because the economic downturn has a negative influence on the success rate of funding applications. Interviewee two highlighted the favourable *Basic factor* of the university's *geographical circumstance*, this comprising, for example, the proximity to industries offering job opportunities for graduates as well as research funding opportunities for researchers. She also defined *geographical circumstance* as a pleasant working and living environment where people like to work for and stay with the university; for example, local authorities provide support for making a built environment for research institutes available with favourable conditions.

In addition, Interviewee three indicated the absence of bequests and criticised the current funding practices which always require an additional contribution from the university and thus limit the opportunity for a full exploration of third party funding. Interviewee three added two further examples of factor advantages, these being drawn from circumstances beyond the university's influence: (1) the historically developed research focus (on the humanities) as a result of a long historical development; (2) the university's current strength in certain research areas because of its proximity to national research institutes such as those of the Max Planck Society or the Helmholtz institutes.

Clearly, what emerges from a summary of the findings after the interviews and related to the *factor-driven stage* is the fact that at this stage all competitive advantage is drawn from historical or geographical circumstances. These factors comprise: historically developed competency in certain research areas; a proximity to industry; a favourable working and living environment; support by local government

Figure 85: Depiction of the relationships between the various aspects of the factor-driven stage as found in this study and in the literature.

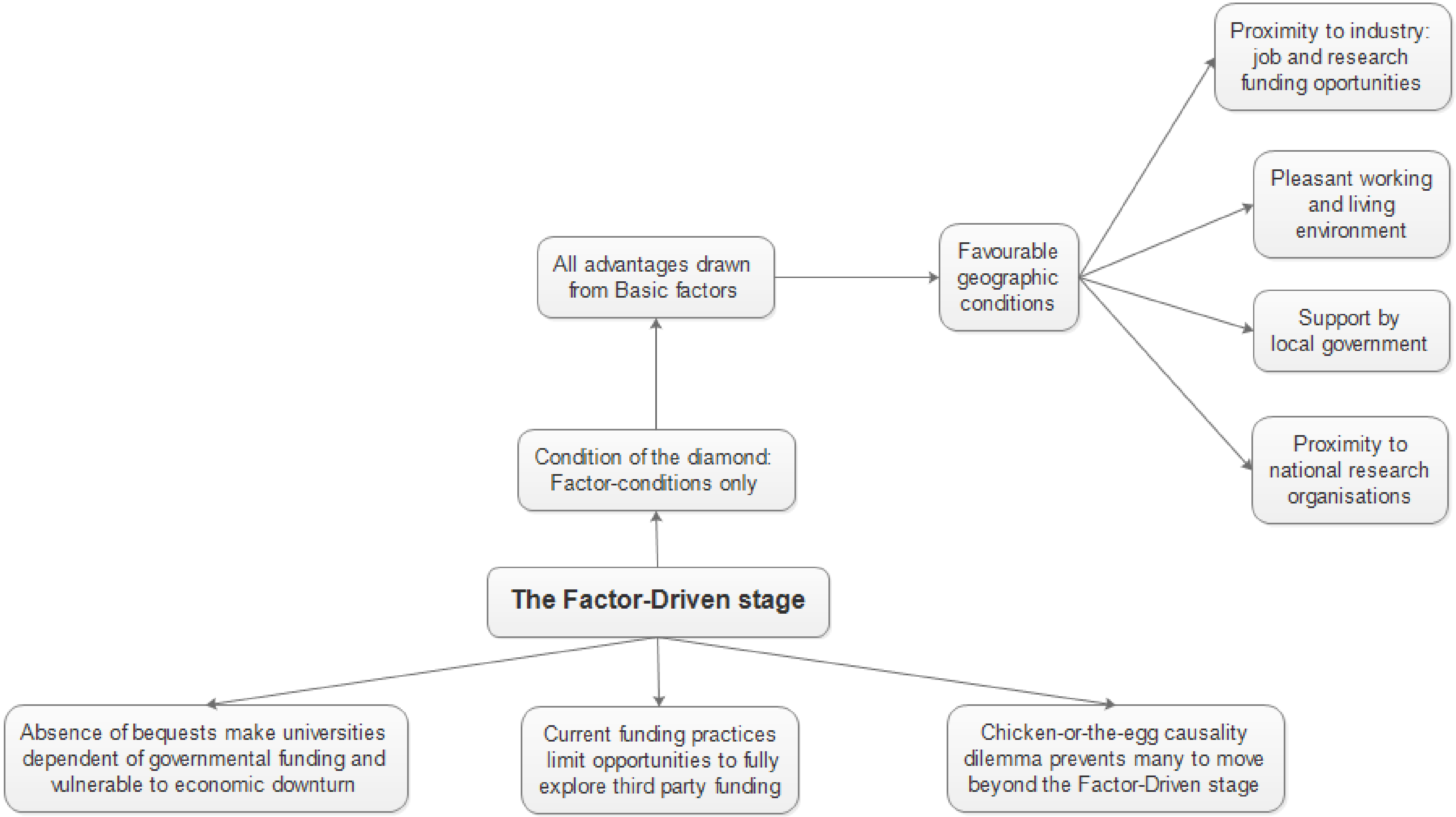


Table 54 shows the findings from the present research, these being congruent with the findings from the UK higher education sector (Curran, 2001) and the corporate sector (Porter, 1998). This congruence makes the evidence emerging from this study believable and authoritative, demonstrating that Porter's model helps to develop an understanding of the dynamic process where university competitive advantage in the *factor-driven stage* is created. The findings further demonstrate that the key driver of upgrading from this stage is increased funding, this however must be achieved in competition. Since universities in the *Factor-Drive stage* possess only a modest competitive advantage and funding is increasingly competitive, a *chicken-or-the-egg* causality dilemma is created which explains why only a few institutions manage to move beyond this stage.

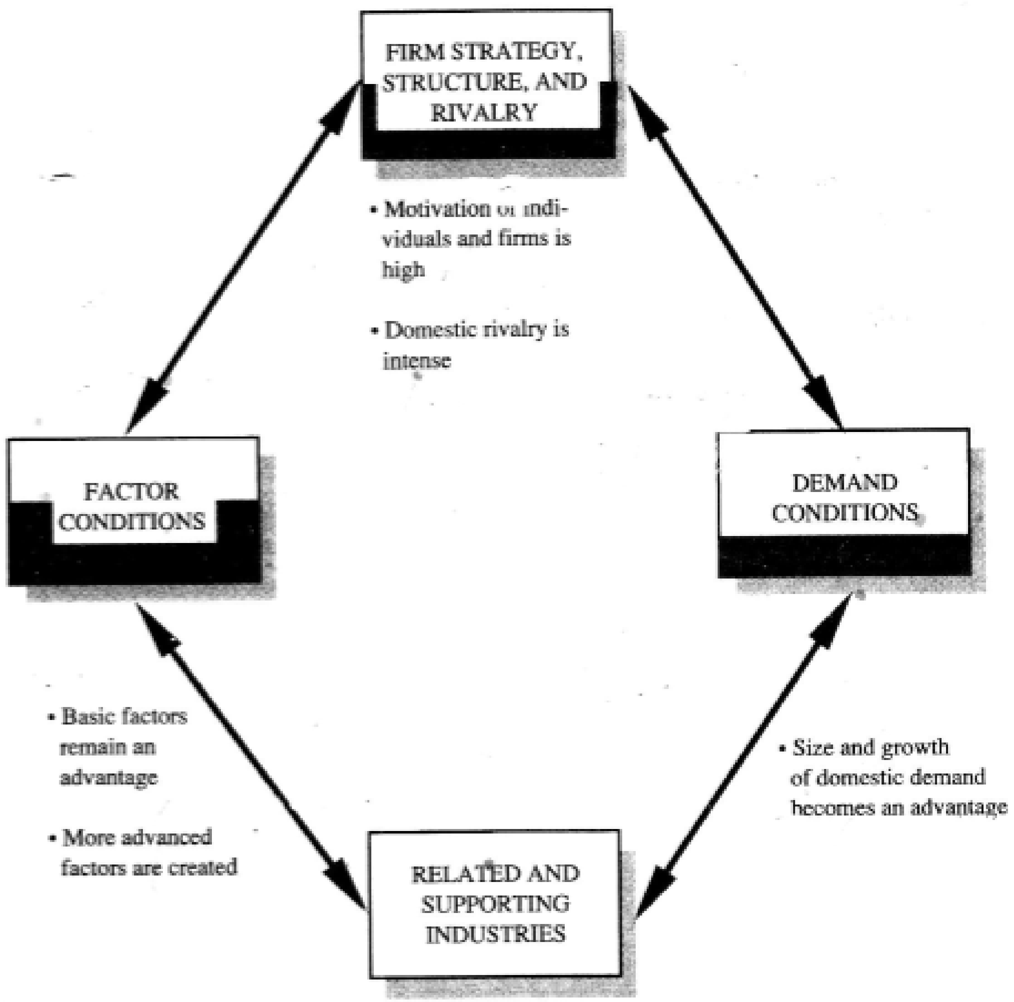
Table 54: Key characteristics of the *factor-driven* stage of competitive development

Name of stage	**factor-driven**	**factor-driven**	**factor-driven**
Source	Porter (1998)	Curran (2001)	The present study
Country/Sector	Denmark, Germany, Italy, Japan, Korea, Singapore, Sweden, Switzerland, UK and US./trading nations	UK higher education/ Geography departments	German higher education/universities
Characteristics	Advantage drawn from basic factors only: geographic location, favourable conditions and available labour pool; Limited opportunity for successful competition; Sensitive to economic cycles; Vulnerable to loss of factor advantage; Few ever move beyond this stage;	Drawing all competitive advantage from the institution; Factor advantages comprise presence of bequests, inheriting previous investments and historical circumstances;	Research focus result of historic developments; Largely dependent on governmental funding; Economic downturn negatively affects success rate of grant applications; Additional institutional funding of grant funded research required; Positive factor geographical conditions comprise: presence of industry, pleasant working and living environment, availability of real estate for research institutes, presence of national research institutes;

6.3 The Investment-Driven Stage

Compared with Figure 87 (*factor-driven* stage), show the diamonds of universities in the *investment-driven stage*, as depicted in Figure 89, that the corners *Firm strategy, structure and rivalry* (in the present study renamed *Strategy, structure and rivalry conditions*) and Demand conditions (in the present study renamed *Ability related conditions to compete*) have come to fruition, whereas the condition of the corner *Factor conditions* (in the present study renamed *Basic conditions to compete*) continues in the same way as in the *factor-driven stage*.

Figure 86: The diamond in the *investment-driven stage*.



Porter, 1998, p. 550.

Earlier research in UK higher education defines the corner *Departmental Strategy, structure and rivalry* as "… how a department is organised / managed and the degree of competitive pressure …" whereas the corner *Demand conditions* is defined as "The demand by the academy for a department's research" (Curran, 2001, p. 224). Earlier research in UK higher education found that in the *investment-driven* stage there were "certain ex-polytechnic departments that had received direct research funding for the first time and certain old university departments with high RAE grades (Curran, 2001, p. 248). This finding indicates that upgrading is dependent on the presence of necessary funding, the latter being available as a result of a deliberate upgrade strategy and resulting in increasing research output.

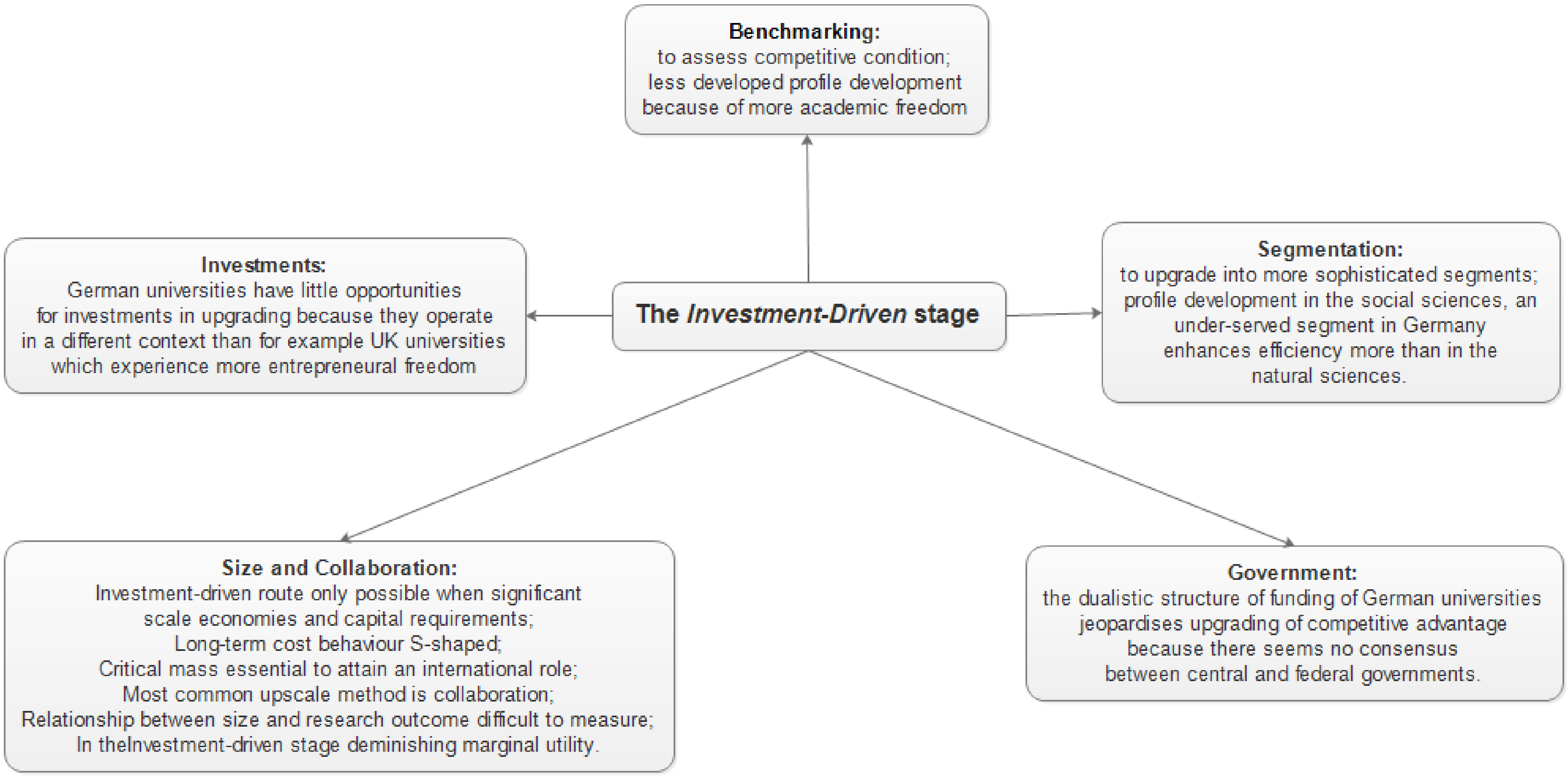
The following discussion of the *investment-driven* stage will focus on five aspects: (1) benchmarking; (2) the segmentation of research areas; (3) the role of the government; (4) investments in facilities, technology and skilled workers; (5) size and collaboration. The relationships between the various aspects of the *investment-driven* stage as discussed in this section of the chapter are depicted in Figure 90.

6.3.1 Benchmarking

Earlier research in UK higher education by Curran (2001, p. 245) recognised benchmarking as a tool that can be used to inform decision-making during the successive steps to upgrade competitiveness. These include focusing research strengths on fewer areas of activity, embracing change and adopting a willingness to aggressively invest so as to increase staff numbers and enhance research facilities. It should be stressed that these activities and the instability they produce belong to an entrepreneurial environment which is common in the private sector but "alien to many academics" (Curran, 2001, p. 245).

From the interviewees' responses it would seem that benchmarking at German universities is mainly used to assess the university's competitive condition and is less for portfolio development (Interviewee 3). On the topic of portfolio development, the first interviewee maintains that university management does not require its researchers to participate in *hot* research topics. Here, Interviewee four, highlights how strong university management is essential for the success of profile development and upgrading, stating: “Once a theme was identified and fitted the policy of the entrepreneurial university, quite some money fled into the project”. When developing or expanding their research profile, most German universities follow a *Focused Differentiation* strategy (Porter, 1998, p. 39), avoiding direct competition where possible, or expanding on existing strengths in particular research areas.

Figure 87: Depiction of the relationships between the various aspects of the investment-driven stage as found in this study and in the literature.



A comparison of the evidence from the German higher education sector with evidence from the UK shows that in the UK benchmarking is used for profile development ("focusing research strength on fewer areas of activity"), this being a relatively undeveloped topic in German higher education. That profile development is still underdeveloped at German universities can be attributed to the academic freedom of German universities where such development is not forced upon the researchers (see also Section 1.3.1).

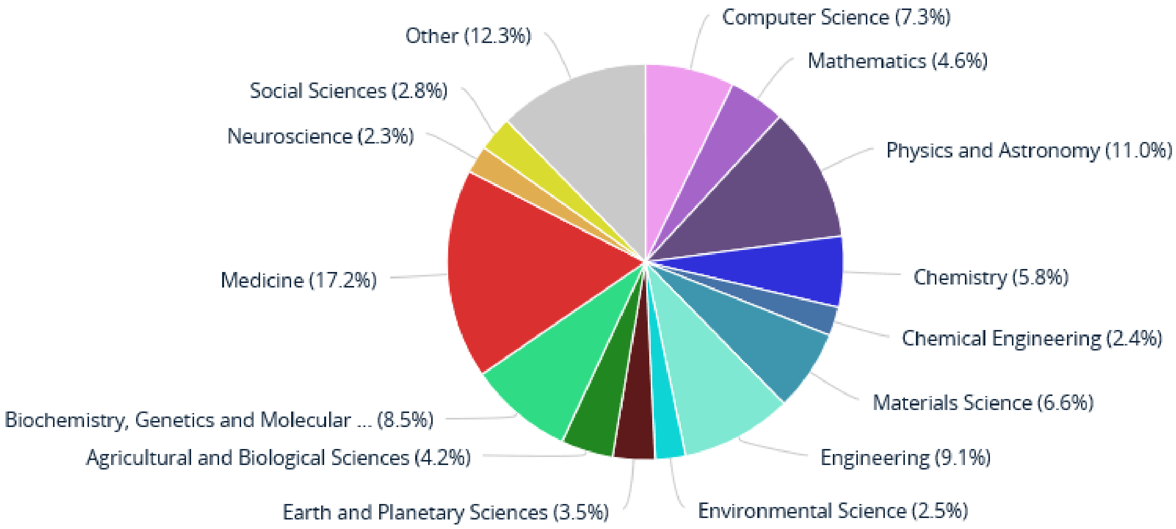
6.3.2 Segmentation

In his description of the *investment-driven* stage highlights Porter the relationship between upgrading into more sophisticated segments and large scale investments in infrastructure. He indicates that success is most likely in those segments that have been ignored by others. Hence, the corner *Demand conditions* is the less developed corner of the diamond in the *investment-driven* stage. He explains the likeliness of success by highlighting that in segments that have been ignored by others investments in large scale facilities have the most significance since foreign facilities may be obsolete or non-existent. However, Porter also highlights that failure is likely to be unavoidable at this stage of competitive development and that the uncertainties involved in building large-scale infrastructure negatively affects the willingness to take risks. The presence of realistic goals that support investments is recognised as an important condition at this stage of development. This also applies to the willingness of the government to play a role in encouraging risk-taking, for example by supporting the building of efficient large-scale facilities (Porter, 1998, pp. 548-552).

Evidence from the UK higher education sector concerning the relationship between upgrading into more sophisticated segments and large- scale investments is largely congruent with Porter's thesis. For example, it features the enhancement of research facilities as one of the characteristics of the *investment-driven stage* (Curran, 2001, p. 245).

As mentioned in Section 6.3.1 emerges from the findings in the multiple case studies that profile development, which plays an important role in the *investment-driven stage,* is largely underdeveloped in Germany (Interviewee 3, see Section 4.3.2.). It was also found that profile development in the natural sciences involves significant investment in large-scale facilities, carrying significant risks. While earlier research suggests that profile development in the social sciences enhances the efficiency of German universities more than profile development in the natural sciences (Warning, 2004, p. 400) an analysis of 732,582 papers of German authors as presented in Figure 91 indicated that the number of papers published in non-natural sciences journals is far less than the number of papers in natural science journals.

Figure 88: Publications of German authors by journal category.



Scival, no date.

The finding that in Germany the upgrading of the competitiveness of research areas is more effective in the social sciences than in the natural sciences, and the finding that the contribution of social science papers by German authors to the total number of papers of their country is about one-third of the contribution of social science papers by UK authors to the total number of papers of their country, suggests that the social sciences in Germany constitute a somewhat ignored segment, offering challenging opportunities for the upgrading the performance of German universities.

6.3.3 Government

Porter highlights how in the *investment-driven stage* the government can play a substantial role in a variety of ways, including: (1) channelling scarce capital; (2) promoting risk-taking; (3) providing temporary protection; (4) stimulating the acquisition of foreign technology; (5) taking the lead in making investments; (6) creating a national consensus about the direction of long-term growth; (7) ensuring adequate domestic rivalry; (8) spurring improvement and innovation (Porter, 1998, pp. 551-552).

What emerges from the interview responses is that the German government plays a pivotal role in the upgrading of the competitive advantage of universities, mainly via *Excellence initiatives*, but also indirectly through the appointment of tenured professors in response to the increasing student numbers. Further, the German government determines the research agenda in Germany via its national funding programs, directly through the Ministry for Teaching and Research (BMDF) and indirectly with the German Research Foundation (DFG). However, the role of the German government in upgrading research performance, this emerging from the responses of the interviewees, seems somewhat paradoxical. On the one hand, it demonstrates that the *Excellence initiatives* and related funding strategies from the national and federal governments in Germany are pivotal in initiating and stimulating the upgrading of research performance in German universities. On the other hand, however, the universities are limited in their opportunities for expansion and upgrading since only the federal government can decide on the number of tenured professors and not the universities themselves.

It therefore seems that the dualistic structure of the funding of German universities jeopardises the upgrading of research because there appears to be no consensus between the national and federal governments about the financing of research.

6.3.4 Investments

Porter highlights how it is essential for reaching the *investment-driven stage* that foreign technology should be absorbed and improved. A prerequisite for this is the availability of increasingly skilled workers, where investment in more skilled workers requires an attitude of risk-taking. In addition to this, the development of enhanced infrastructure is also required for the upgrading of *Basic factors* into *Advanced factors*, the latter being more specialised and highly significant for the upgrading of the competitive advantage (Porter, 1998, pp. 548-549). As result, the available factors are likely to be more efficiently used and will lead to improved performance. Thus, organisations with the greatest ability and willingness to invest will have the most advantage.

The results of research on the topic of investments in UK higher education are congruent with Porter's thesis, recognising that "… in the investment-driven stage departments embrace change and invest aggressively in the upgrading of their competitive position by increasing staff numbers, enhancing facilities and focussing their research strength on fewer areas of activity" (Johnston, 1995, as cited in Curran, 2001, p. 245).

It is clear from the interview responses that the context for German universities to significantly upgrade (with the exception of the opportunities offered by the *Excellence initiatives)* is largely missing. This brings about a *chicken-or-the-egg* causality dilemma since the additional funding required for investments into upgrading will only become available as a result of these investments.

The context in which German universities operate is described in Olsen's *Institutional state model*, highlighting how universities enjoy academic freedom and are assessed for their effects on the structure of meanings and norms (Himanen et al., 2009, p.421). Here, differences with universities in the UK can be explained because they operate in different contexts, this being described by Olsen as the *Supermarket model*. In this model, the role of universities is to deliver services such as teaching and research so that the role of the state is minimal and universities are assessed on entrepreneurial criteria such as efficiency, economy, flexibility and survival (Himanen et al., 2009, p. 421). A comparison of the contexts of German and UK universities here suggests that

UK universities enjoy more entrepreneurial freedom, which may lead to the successful pursuance of greater opportunities for upgrading.

6.3.5 Size and Collaboration

Porter maintains that “the investment-driven route to competitive advantage is only possible … in those [industries] with significant scale economies and capital requirements …” (Porter, 1998, p. 551). Earlier research of long-running costs’ behaviour in higher education suggests classical shaped cost-curves depicting the relationship between the size of the institution and the cost behaviour within the context of classical microeconomic economies of scale (Maynard, 1971, pp. 88-89). Other studies analysing how the size of higher education organisations affect research productivity are scarce. Research in the late 1980s analysing US academic research departments in 23 disciplines found that “publishing activity increases with department size at [a] diminishing rate” (Jordan et al., 1988 & 1989, as cited in Abramo et al., 2012, p. 703). However, later research in the early 1990s using the same dataset found that the impact of size on productivity was questionable (Golden and Carstensen, 1992, as cited in Abramo et al., 2012, p.703). However, more recently, a study analysing 180 Norwegian research groups in microbiology concluded that “… the number of articles per capita was independent of group size (Seglen and Asknes, 2000, as cited in Abramo et al., 2012, p.703).

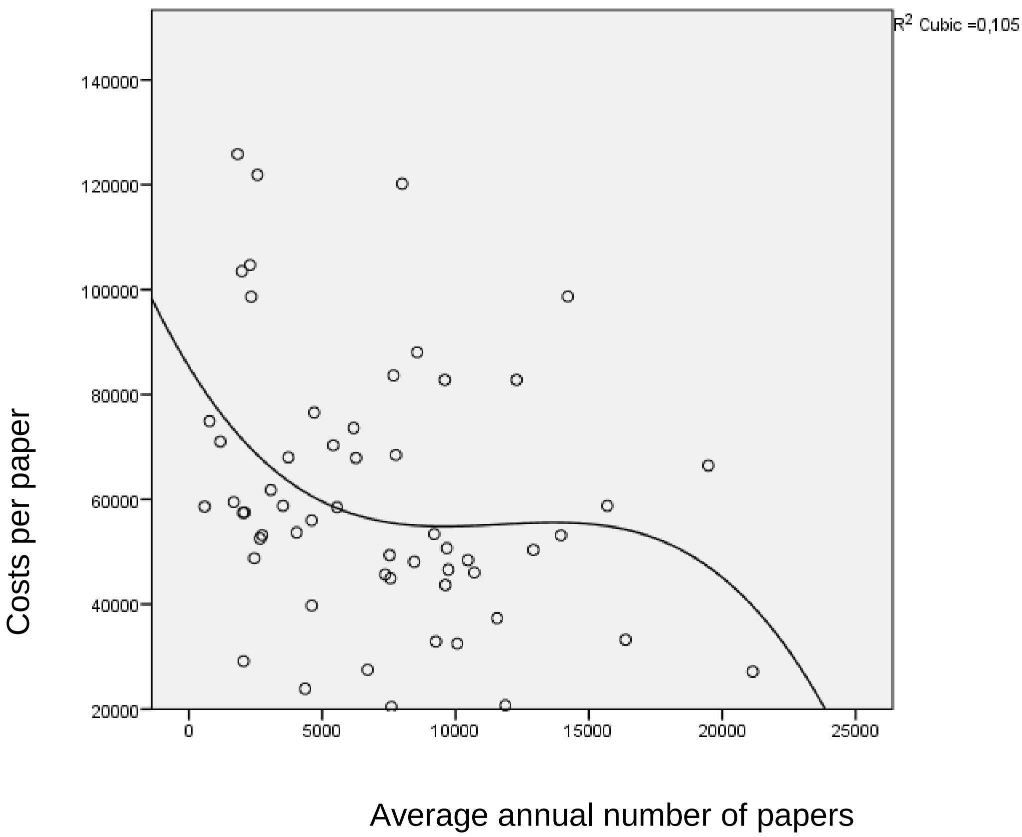
Despite the paucity of literature on this topic, the relationship between performance and size has emerged from all the interviews. Interviewee one maintained that he collaborated with a nearby university to reach a *critical size* and as a result managed to become part of the *Excellence initiatives* and could benefit from the accompanying significant funding. He indicated how: “The larger the department, the larger the likelihood of higher output”. Interviewee two also maintains that *size* plays a crucial role in upgrading research performance, stating how: “We could not get special funding from the *Excellence Initiatives* because we were not so large”. Further to this, Interviewee four referred to the relevance of a *critical mass,* declaring: “In the late-90s the management of the university realised that a critical mass of students, researchers and funding is essential to attain an international role".

However, it also emerged from the interviews that the current size of German universities is the result of historical circumstance and is not of an ongoing deliberate expansion strategy. For example, the Ludwig-Maximilian University with 54,618 students and staff the largest university in Germany, was founded in 1472. In the context of the aforementioned limited opportunities for investments, the most commonly used method to upscale research capacity is through collaboration, especially collaboration with national research organisations such as the Max Planck Society or nearby universities, and here interdisciplinary collaboration emerged from the interviews as a successful form of collaboration.

The confusing outcomes of studies into the relationship between the size of the institution and cost behaviour have come about because the determination of such a relationship is complicated by a number of factors. For example, the modalities of research outcomes are different in the various disciplines (e.g. journal papers, book chapters, books and exhibition catalogues) and universities subdivide their research areas into different levels of specificity which makes comparisons difficult. In addition, the research outcome per capita differs greatly over the disciplines. For example, the average research output per capita in physics is 1.733, and in civil engineering 0.254 (Abramo et al., 2012, p.704). Despite these caveats, this study assumes that the sum of all influences other than *size* on the cost per unit output equals the effect of each of the individual conditions when taking the entire university as unit of analysis.

Figure 92 depicts the functional relationship between the university's research effectiveness, as expressed by the cost per unit output (= cost per paper published) and the volume of the average annual research output (= average annual number of papers published) of the sample of German universities included in this study.

Figure 89: Functional relationship between research effectiveness and output volume.



In Figure 92, the S-shaped cost function depicts the declining costs per unit research output when the volume of research is increasing. An example of this phenomenon can be found in the *investment-driven* stage where investments in infrastructure, staff, etc., result in declining costs per unit output until a certain level of economies of scale has been realised and a semi-constant level of cost per unit research output is reached. This semi-constant level is the result of a diminishing marginal utility until a threshold level has been reached when full (staff and infrastructural) capacity is utilised and further increased in research output results in a linear development of the costs per unit output. The recurring and declining cost- per-unit-research output when the volume of the research output further increases can be explained by synergies emerging when the full diamond comes into shape in the *innovation-driven* stage of competitive development and is discussed in the following sub-section of this chapter.

The cost-per-research-output in this study is based on the amount of research funding (Drittmittel). This excludes the financial contribution of the university from its basic funding and therefore the real cost curve will be at a significant higher level, but will have the same general shape as the curve in Figure 92. A semi-informed guess establishes the average costs per research output in the natural sciences at about € 175,000, about double the level depicted in Figure 92, confirming that universities and other funders contribute up to about 50% of the cost of third-party funded research.

Since research funding is largely determined by subjective criteria such as the supposed quality of a faculty, governments tend to concentrate their research more often on the support of a few institutions with a very good reputation. This creates a *Mathew-effect* (Merton, 1988, pp. 606-623; Moed, 1998, p. 249, see Section 1.2) in higher education, where the very large sized *multiversities* are favoured (Maynard, 1971, pp. 133-138). The consequences of this phenomenon are expressed in the following quote:

> *Speculators about the future concept of higher education in Germany foresee the fostering of 5 large-scale elite universities and of 20 universities which are world-class in certain research areas, alongside a vast body of mediocre educationally focused universities.*

Interviewee three.

In sum, what has emerged from the discussion about the *investment-driven* stage is the fact that benchmarking should be fully employed to inform decision-making as regards profile development via pursuing a strategy of *Focussed-differentiation;* here, opportunities for upgrading positions in social sciences research areas could well exist and be under-exploited. Size and mass are critical for upgrading at this stage of development, but opportunities for investment into expansion are limited because of the current funding structure facing universities, so creating a *chicken-or-the-egg* causality dilemma. Here, possibilities for increasing size through collaboration should be pursued to overcome this dilemma. In the current context, funding practises seems to result in the creation of a *Matthew*-effect favouring the already large universities. Moreover, the discussion about the factors in this section of the chapter show that the essential context for an *entrepreneurial university* is missing in Germany – and the current dualistic structure of government funding creates but also limits the opportunities for upgrading.

Table 55: Key characteristics of the *investment-driven* stage of competitive development.

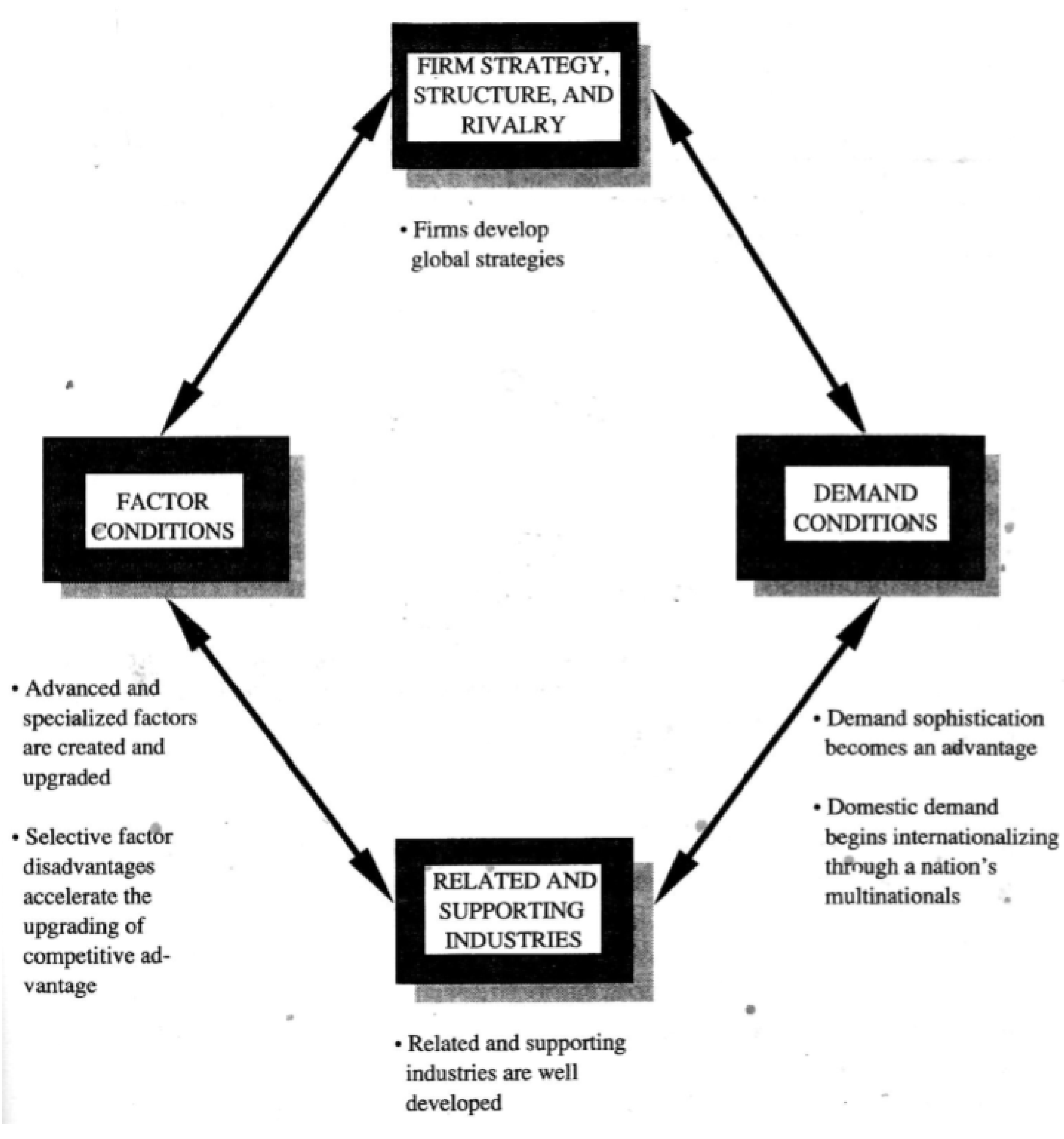
Name of stage	investment-driven	investment-driven	investment-driven
Source	Porter (1998)	Curran (2001)	This study
Country/Sector	Denmark, Germany, Italy, Japan, Korea, Singapore, Sweden, Switzerland, UK, and US./trading nations	UK/Geography departments	German higher education
Characteristics	*Strategy and Structure* conditions come to fruition driven by natural *Rivalry*; willingness and ability to invest aggressively in large scale facilities and a skilled work force; creation of joint-ventures; risk-taking; improving factor-conditions; related and supporting industries largely undeveloped; government takes the lead in making investments possible;	Strategy and structure informed by benchmarking; departments embrace change and invest aggressively; increasing staff numbers, enhancing research facilities; greater focus on fewer strengths;	Benchmarking insufficiently employed as a basis for profile development; profile development through *Focused differentiation* strategy; lack of full exploration of underserved research areas with strong positions; threshold critical mass of students, researchers and funding essential for upgrading; size determines opportunities for upgrading; limited opportunities for growth - size mostly as a result of historical growth; positive relationship between size and performance; current funding practices create “Matthew effect”; dualistic structure of governmental funding limits opportunities for upgrading; essential context for entrepreneurial university appears to be missing;

			factors affecting performance form a causal chain; funding largely determined by supposed quality of faculty; upgrading from basic factors into advanced factors;

6.4 The Innovation-Driven Stage

As shown in Figure 93 and compared with Figures 87 (*factor-driven* stage) and 89 (*investment-driven* stage*),* in the diamond of the *innovation-driven* stage all the corners are fully developed.

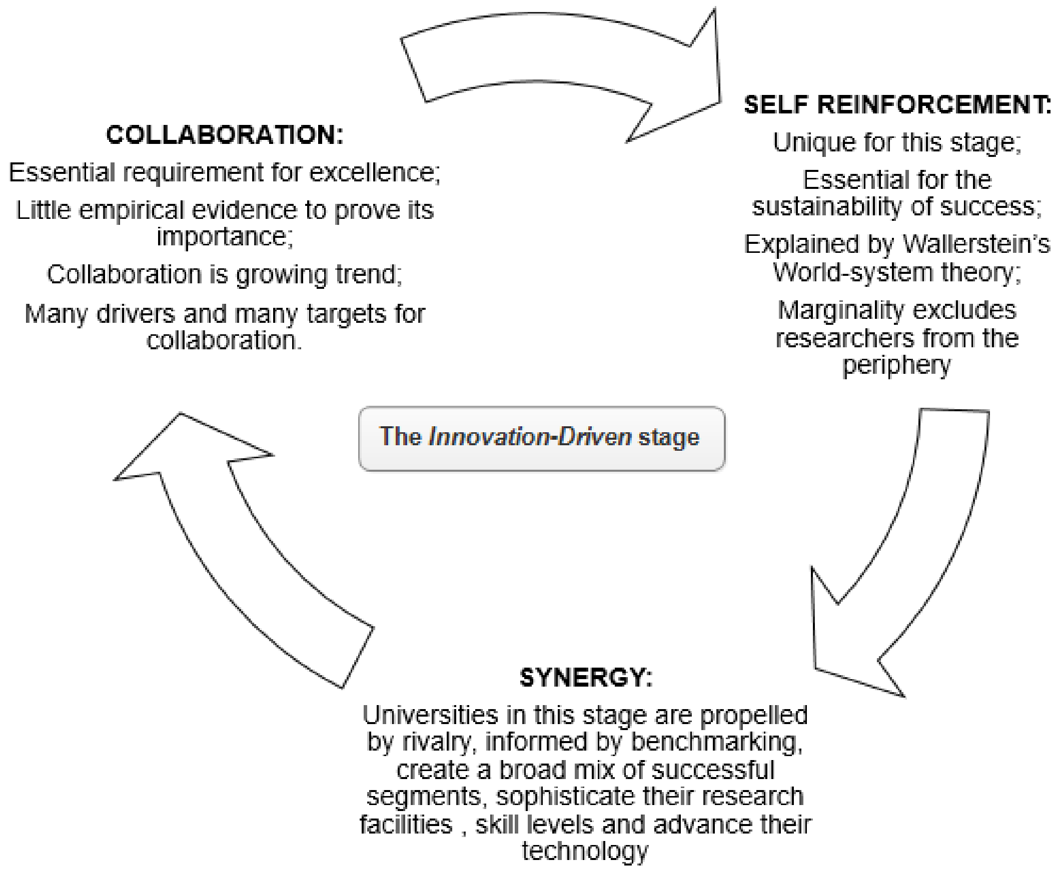
Figure 90: The *innovation-driven* stage



Porter, 1998, p. 553.

The relationships between the various aspects of the *innovation-driven* stage as discussed in this section of the chapter are depicted in Figure 94.

Figure 91: Depiction of the relationships between the various aspects of the innovation-driven stage as found in this study and in the literature



The dynamics of the trajectory from the *investment-driven* stage into the *innovation-driven* stage involve a continual upgrading of the corners with *Factor conditions / Basic conditions to compete*, *Firm strategy, structure, and rivalry / Strategy, structure and rivalry conditions* and *Demand conditions / Ability related conditions to compete.* This should be done until full fruition is achieved, and with the emergence and complete development of the corner *Related and supporting industries / Collaborator and role model conditions*.

Porter describes the dynamics in the *innovation-driven* stage as being propelled by rivalry and being informed by benchmarking, pursuing a strategy of vertical deepening followed by horizontal widening. This creates a broad mix of successful segments and offers increased opportunities for cross-fertilisation so that the role of the government as an impetus of innovation loses its relevance. Continuing investment, making research facilities, skill levels and advanced technology more sophisticated leads to the creation of new technologies and improves their position in terms of their being global and state-of-the-art. This is made possible through collaboration and clustering, with equal world-leading related industries; the latter making the industries at this stage resistant to macroeconomic fluctuations and exogenous events (Porter, 1998, pp. 552-556).

Findings from the UK higher education sector are largely congruent with Porter's thesis. Earlier research in the UK found in the *innovation-driven* stage old universities with a high absolute performance in research, this being described as the result of a long-term view on research performance; it was fostered by an innovative culture and a willingness to take risks so that the research environment is continuously upgraded through innovation as a result of inward investment in research departments as well as in the development of close collaborations. At this stage, clusters are created that transcend departmental boundaries. Universities in the *innovation-driven stage* attract excellent research staff, post- and undergraduates, and can successfully apply for the most competitive funding sources as well as submit successfully to the most demanding journals and publishers. Here, universities steer the international research agenda and explore new areas of intellectual activity. All of this makes universities at this stage less dependent on national governmental funding (Curran, 2001, pp. 246 - 248).

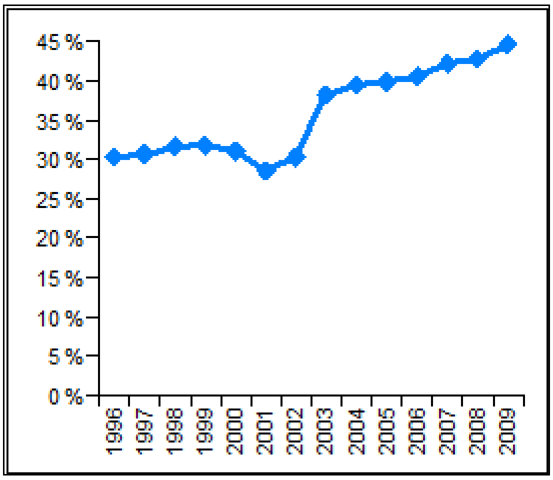
6.4.1 Collaborator and Role Model Conditions in the Full Diamond

Since the upgrading of the corners *Factor conditions / Basic conditions to compete*, *Firm strategy, structure, and rivalry / Strategy, structure, and rivalry conditions* and *Demand conditions / Ability related conditions to compete* - have been discussed in the previous sections of this chapter, this section will focus on the emergence and full development of the corner *Related and supporting industries / Collaborator and role model conditions*.

The importance of collaboration is demonstrated in the following quote by Hannah Arendt, who discussed the relationship between excellence and collaboration, stating the view that "…[to have] excellence, by definition, the presence of others is always required" (McGowan, 1997, p. 41). In the literature, collaboration is recognised as the thrust for the creation of new scientific knowledge but little empirical evidence is available concerning its role. This paucity of empirical evidence is largely because individual data is generally unavailable and causal effects are difficult to uncover (Azoulay, Zivin and Wang, 2010, p. 550).

Empirical evidence on the scale of international collaboration by German authors is presented in Figure 95, this showing a growing trend for papers which are published in collaboration with authors from another country.

Figure 92: Percentage of papers from German authors published with authors from another country.



MASSCOPU, 2014.

More recent research by Benavent-Perez et al. (2012, pp. 53-54) shows a positive correlation between the number of collaborators and the normalized impact[35]. For instance, they find that "… a continuously reduced percentage of the domestic (non-collaboration) academic output is a world trend" and that Harvard has an extremely low percentage (15%) of publications without collaboration. However, it was also discovered that differences occur between the disciplines so that the Arts & Humanities in addition to the Social Sciences are the research areas with the most *non-collaboration* output.

[35] Normalised impact is the "ratio of the average institutional scientific impact to the world average impact of publications of the same time frame, document type and subject area" (Benavent-Perez, Gorraiz and Gumpenberger, 2012, p. 44).

Other earlier studies in higher education identify an array of drivers of collaboration: the specialisation of science, the international differentiation of disciplines, ever-growing complexities in science and disciplines, the cross-fertilisation of disciplines, data, access to sophisticated and expensive equipment, the pooling of resources, talents, skills and knowledge, mutually beneficial results merging the scientific assets of the partners, the desire to enhance professional visibility, career advancement, improved productivity, changing patterns of funding, advancement in communication technologies and reduced isolation (Schubert and Sooryamoorthy, 2010, p. 194).

Increased collaboration is for some time also driven by the aim to lessen the dependence on governmental support. For example, the Scottish Higher Education Funding Council (SHEFC) in the mid-1990s viewed collaboration as the logical response to reducing the government's funding of higher education. These views draw on the Daring Committee report (1997) which predicted that the *"…need for collaboration will increase in future. It will derive strongly from the extended use of communications and information technology and from a stronger emphasis on the local and regional role of institution[s]"* (Sizer and Durnin, 1998, p. 123).

Not surprisingly, Interviewee four, whose university is in the *innovation-driven* stage, is very outspoken on the topic of collaboration, highlighting the culture of the university as an important factor when embracing opportunities for collaboration. For her, *"the university is very strategically and pragmatically focused … the immediacy to application is historically grown into the culture of our university which is an advantage for the collaboration with industry".* She went on to argue how international collaboration is a pivotal component of the university strategy: *"Internationalisation is a strategic main focus. We have expanded our worldwide network into the Middle East and North Africa and have now offices in, for example, in Sao Paulo, Beijing, Brussels, Singapore, Mumbai, and Cairo".*

Not only international collaboration, but also interfaculty collaboration is fostered at the university of Interviewee four. Here, she indicates how "[a] university like ours has of course always some level of international collaboration, but is also stimulating interfaculty cooperation by means of a matrix-structure crossing faculty borders and fostering the development of interfaculty research centres".

A broad spectrum of targets for collaboration emerges from the multiple case studies. Interviewee one reported on collaboration with a nearby university with the result that they can play in a *different league* because of the successful creation of an *Excellence Cluster* (Section 4.3.2 of this thesis). Interviewee three, discussing interdisciplinary and international collaboration, states how: *"for example, the Excellence Cluster Molecular Imaging combines contributions from the disciplines medicine, chemistry, physics, mathematics and informatics. External collaboration is further sought in certain targeted countries".*

Interviewee four refers to a program stimulating international institutional cooperation and encompassing the appointing of visiting professors, the international recruitment of tenured professors, the creation of remote joint-institutes, etc. Here, she elaborates on international collaboration: "International collaboration is pursued via an exchange of persons: firstly via a guest-lecturer program, and secondly via a tenured appointment program by which international background is a key criterion… [and] … we have built alliances with a number of similar universities, for example the ETH Zurich".

She also elaborates extensively on collaboration with nearby industry, as featured by a focus on feasibility, market needs and the cooperation of her university (Section 4.9.1). In terms of the advantages of collaborating with industry, she states that: "the presence of the headquarters of multinationals offers the opportunity to build a pool from which the university and the industry can mutually recruit … [and] … the building of the Institute for Advanced Study was completely sponsored by the industry".

Moreover, all the interviewees in this study are unanimous in the advantages of collaboration with national research organisations such as the Max Planck Society and the Helmholtz Association.

In sum, in this sub-section of the chapter, collaboration is highlighted as an essential requirement for excellence and is therefore pivotal in the *innovation-driven* stage of competitive development. Despite little empirical evidence being available to prove its importance, collaboration emerges as a growing trend both from the literature and from the interview responses. Here it is possible to identify a broad spectrum of drivers for collaboration. Not surprisingly, the interviewee from the university in the *innovation-driven* stage is the most outspoken about collaborations, but in all the interview responses a wide spectrum of collaboration targets was indicated.

6.4.2 Self-Reinforcement of the Full Diamond

Also somewhat underexposed in the earlier descriptions of the *innovation-driven* stage is the self-reinforcement of this condition, which is unique for this stage compared with the other stages of competitive development and which is essential for the sustainability of success in this stage. The self-reinforcement of this stage can be explained by Wallerstein's *World-system theory*, this being based on the following idea:

> *The division of a world-economy involves a hierarchy of occupational tasks, in which tasks requiring higher levels of skill and greater capitalization are reserved for higher-ranking areas. The … maldistribution of these occupational skills involves a strong trend toward self-maintenance.*

(Wallerstein, 1976, p. 230).

Marginality is the key concept in the *centre-periphery* model. In the higher education sector, marginality excludes researchers at the periphery from activities taking place in the centres or cores. These may comprise activities such as researchers embedding research into the larger scientific community, receiving research funding, exploiting collaboration opportunities, etc. According to this theory, locate factors such as geographical location or the reputation of the university researchers in the periphery which prevents even great researchers from reaching the centre. Consequently, this *centre-periphery* effect also results in researchers being favoured who have a good geographical location or belong to a reputable university . Hence, because of scientific marginality, the Mathew-effect is reflected in the self-reinforcing process when the full diamond is in place.

The discussion in this sub-section of the chapter and the information shown in Table 56 demonstrate that the self-reinforcement of the full diamond is unique for the *innovation-driven* stage, making universities at this stage far less vulnerable to a loss of competitive advantage than universities at other stages of development. This self-reinforcement draws largely on collaboration with equal world-class partners and is depicted by an *over-par* performance in *Collaborator and role model* conditions. A focus on collaboration is aimed at upgrading performance and becoming less dependent of the nation's governmental funding; to this end, universities push resources, talent and knowledge.

The self- reinforcement of the diamond at this stage can be depicted as a vicious circle where universities at the core of the science system collaborate with other universities in the centre of the system. This results in an increased research reputation, attracting top researchers as well as top post- and undergraduates who further reinforce the desirability of the university as a collaborating partner, a place to study and a place to do research.

It is therefore surprising that there is a paucity of empirical evidence in the literature on the role and nature of collaboration. Possible reasons for this scarcity are the unavailability of individual data and the difficulty of uncovering causal effects. Hence, the discussion in this sub-section of the chapter further reveals that the empirical evidence from this study as well as from earlier research is largely congruent with Porter's thesis. Although the phenomenon of self-reinforcement is somewhat underexposed, this study shows how the model of Porter's thesis of the *innovation-driven stage* is useful for structuring the assessment of university performance and explains the dynamics and attributes of universities at this stage of competitive development.

The outcomes of the current study as discussed in section 6.5.3 of this chapter demonstrate that in German higher education the highest increase in research output is found with the few top universities in the *innovation-driven stage*. This outcome further shows, as shown in Figure 98 and Figure 99, that each of the five German elite universities have not lost their competitive edge during the last three decades. Additionally, the share between elite universities and non-elite universities has remained stable, with a stable share for the five German elite universities of 14% over the last three decades.

Factor driven prosperity is absent in German higher education because of the non-existence of significant bequests; favourable factor conditions such as a historically developed research focus, the presence of industry, a favourable working and living environment and the presence of national research institutes are not strong enough to create factor-driven prosperity.

Further to this, there is amongst the German universities in the *investment-driven* stage a lack of opportunities to invest on a large enough scale in technology or in *star* researchers to improve their productivity and prosperity so that they attain the self-reinforcing *innovation-driven* stage.

In sum, the findings of the present research support Porter's proposition that true prosperity is only found in the *innovation-driven* stage (Porter, 1998, p. 554). This study demonstrates that the few elite universities in this stage of competitive development show fully developed and self-reinforcing diamonds. The findings here are congruent with Curran's finding in the *innovation-driven* stage a few old universities with a high absolute performance (Curran, 2001, p. 248).

Table 56: Key characteristics of the *innovation-driven* stage of competitive development

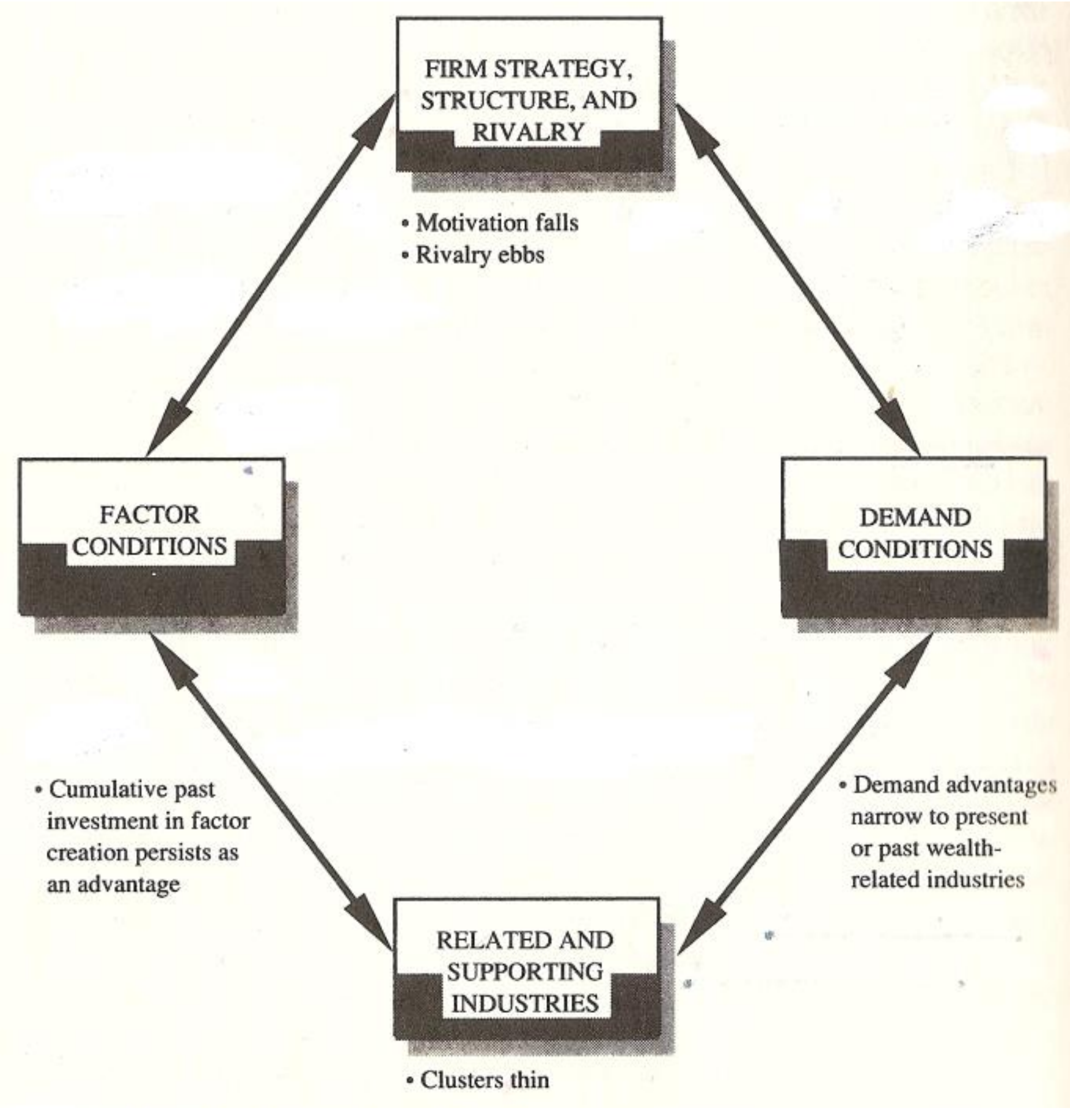
Name of stage	**innovation-driven**	**innovation-driven**	**innovation-driven**	**innovation-driven vs. other stages**	**innovation-driven**
Source	Porter (1998)	Curran (2001)	Mohrman, Ma and Baker (2008)	Schubert and Sooryamoorthy (2010)	This study
Country / Sector	Denmark, Germany, Italy, Japan, Korea, Singapore, Sweden, Switzerland, UK, and US./trading nations	UK/Geography departments	Top research universities worldwide	Universities in the core and in the periphery	German higher education
Characteristics	*Related and Supporting Department* conditions evolve from barely significant to pivotal component; interfaculty collaboration with world-class supporting departments and extra-institutional partners; expanding networks, increasing cross-fertilisation and a growing reputation; fewer management control and hierarchical arrangements.	Old universities with high absolute research performance; thought-leaders of the international research agenda; attracting like a magnet research-excellence staff, post-graduates and undergraduates; investing in intra-institutional collaborations; transcending departmental boundaries; foraying into new research areas.	Transcending a nation's boundaries; use of scientific methods outside the sciences; team-oriented, cross-disciplinary, international faculty directed to real-world problems; funding from corporations, private donors, competitive grants and for-business spin-offs; relationships and participation with universities, governments, NGOs and corporations; world-wide recruitment;	Marginality favours researchers in the centre, embedding their research in the larger scientific community, receiving funding and exploiting collaboration; based on location, reputation and favourable starting conditions, not on capabilities of individual researchers.	Exploiting favourable historically developed orientation; (international) collaboration key component of university strategy; pursuance of international and interfaculty collaboration; wide array of extra-institutional partners; focus on world-class collaborators sustains self-reinforcement; positive relationship between collaboration and impact;

			interdisciplinary centres, integration of research in student training, greater technological infrastructure;		creation of remote joint-institutes; immediacy to industry featured by focus on feasibility, market needs and cooperation; collaboration with nationwide research organisations; international recruitment; reduced governmental dependence.

6.5 The Genteel-Decline (Wealth-Driven) Stage

As shown in Figure 96 and in comparison to Figure 93 (the *innovation-driven* stage), the diamond of the *Genteel-decline (wealth-driven)* stage shows the disappearance of *above-par* performance for all the corners. The dynamics in the *wealth-driven* stage are determined by a strategy aimed at “preserving position [rather] than ..enhancing it” (Porter, 1998, p. 556). This leads to drift and ultimate decline, which is depicted as a *below-par* condition of the *Strategy, structure and rivalry* corner of the diamond at this stage.

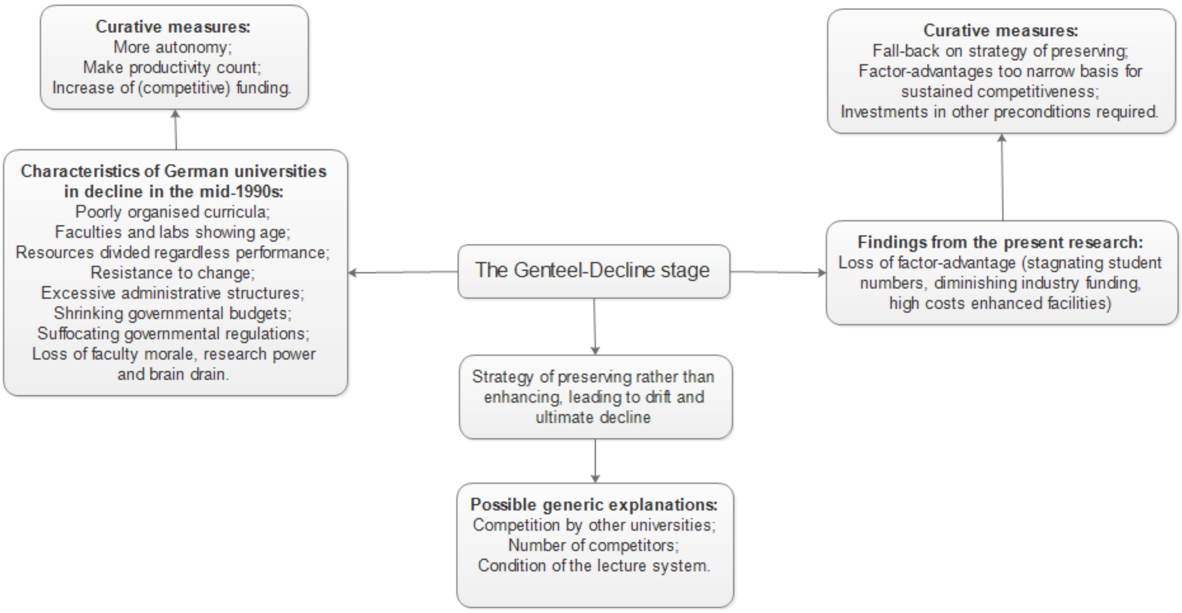
Figure 93: The wealth-driven stage.



Porter, 1998, p. 558.

Within the context "… of what anthropologists would call cultural replication … [by which] … values cross from one domain … to another and then, in altered form back again by which new vocabulary may emerge", (Strathern, 1997, pp. 118-119) seems Curran's characterisation of universities at this point as being in a stage of "*Genteel-decline"* (Curran, 2001, p. 247) more appropriate for the higher education sector than *wealth-driven* and will henceforth be used to refer to the fourth and final *Stage of Competitive Development* in higher education. The relationships between the various aspects of the Genteel-decline stage, as discussed in this section of the chapter, are depicted in Figure 97.

Figure 94: Depiction of the relationships between the various aspects of the *genteel-decline* stage as found in this study and in the literature.



6.5.1 Characteristics of Genteel-decline stage

Porter (1998, pp. 556-560) describes a number of characteristics of the *wealth-driven stage* which also bear relevance to the higher education sector. He highlights how that termination of the creation of new wealth leads to a chain of reactions comprising a decreased appetite for risk-taking and resulting in chronic under-investment in innovation and upgrading; this leads to decreasing prestige and a loss of employee motivation. The tangible signs of being in the *wealth-driven stage* may not be directly recognised, and patchy competitive advantage could persist in particularly unique segments: (1) those where advanced demand continues because of accumulated wealth; (2) those where competitive advantage draws on the cumulative investments of a long period of time (for example, a highly trained labour force or capital-intensive infrastructure) ; (3) those where durable competitiveness is based on historical success or the absence of discontinuous innovation; (4) where Basic-factor advantages remain (Porter, 1998, p. 559).

UK universities at this stage of competitive development are described by Curran as drawing competitive strength from staffing and research facilities which have previously suffered chronic under-investments, shown complacency and lacked competitive vitality. Curran further affirms Porter's assertion that the transfer into the *wealth-driven stage* is "almost imperceptible … as reputation, research influence and even citation scores can lag behind research reality by a decade or more" (Curran, 2001, p. 248).

6.5.2 Values in the Genteel-Decline Stage

Here, Curran characterises UK universities in the *wealth-driven* stage by "… complacency, lack of competitive vitality and an increasing emphasis on the redistribution rather than the creation of wealth" (Curran, 2001, p. 248). However, these characteristics do not emerge from the interviews. The outcomes of the interviews are however congruent with Curran's findings that universities at this stage are suffering from chronic underinvestment and follow a strategy with an emphasis on stability. Here, the absence of complacency and lack of competitive vitality is explained by the concept of *values* which differ in the higher education sector from those in the private sector. In the corporate sector, workers are influenced, persuaded and motivated by rewards, goals and management directives, while in the higher education sector, scholars are influenced, persuaded and motivated by peers and academic prestige (Kezar, 2005, p. 857). However, this explanation does not explain the differences between the higher education sector in the UK and in Germany and hence further research on this topic is recommended.

6.5.3 Causes for Genteel-Decline in German Higher Education

Attempts to explain why some universities find themselves in a stage of (Genteel-) decline are nothing new as demonstrated by the following quote, which was presented in an editorial from 1897:

> *There is no doubt that, tested by the number of matriculated students, the Scottish universities [are] registering a steady decline … to be explained in diverse ways … the more aspiring youth prefer Oxford and Cambridge to Edinburgh or Aberdeen … the poverty of the career open to the graduate, the teaching profession being almost the only metier in which his qualifications are marketable … the Scottish M.A.* [that] *has never carried with it the same guarantee of thoroughness and academic status implied by that of Cambridge and Oxford … the excessive number of "seats of learning" north of the Tweed … the lecture system … an effete survival from the Middle Ages … preposterously overdone … and the best of her sons are precisely those whom she can least powerfully attract to her own service.*

(No author, The Lancet, 1897, pp. 1221-1222).

Explanations about why in the mid-1990s universities in Germany found themselves in a stage of (Genteel-) decline emerge from the following quote describing how after two decades of stagnant funding the condition of the German science system was underfunded and overcrowded, this being characterised by: "poorly organised curricula with little guidance; some faculties and research labs … showing their age …and basic resources … divided equally among professors, regardless of their productivity" (Kahn, 1996, p. 172). The German universities had in part caused these problems themselves because of their resistance to change and the creation of excessive administrative structures, but the problems had also partially been victim to shrinking governmental budgets and suffocating governmental regulations. This condition of higher education resulted in a loss of faculty morale and research power and a *brain drain* of faculty and students to foreign or non-university laboratories.

Several curative approaches have been undertaken since then to improve the condition of German higher education including state governments giving universities more autonomy and made productivity count. The Volkswagen Foundation has also supported seven German universities with $12.4 million to create conditions for autonomy. Further was quality control of research efforts reinforced and was declining basic support for universities compensated with a 5% yearly increase in competitive research funding via the German Research Council (DFG) (Kahn, 1996, p. 173). Such approaches were largely successful, as for example, with the Humboldt-University of Berlin, a former DDR university, now one of the leading universities in Germany.

In addition to a *autonomy* emerged *governance* as another key element to achieve more with less funding. In higher education "administrative matters are regarded as unimportant and managerial decisions are usually taken at the last minute with little consideration for the consequences" (Marty, 2012, p. 28). Moreover, when academics use their autonomy to perform administrative tasks, they waste a great deal of precious research time. This can be avoided if the autonomy of researchers is reduced to autonomy in the right places only. Another observation is that "decisions are often taken at the wrong level of hierarchy, involving too many people or [with] too great [a] focus on details" (Marty, 2012, p. 28). As a result, decision making is often focused on participation and consensus rather than on the best solutions. An example of the focus on consensus and the distrust of leaders in higher education can be seen where many decision makers such as deans, institute directors and university presidents have only short 2 to 4 year terms, which limits their executive power and makes it difficult for them to introduce and pursue structural improvements (Marty, 2012, p. 28).

A contemporary picture of a university in the *Genteel-decline* stage was sketched by Interviewee three when he reported on the favourable demographic

(=*Factor*) conditions. Here, the significant increase in student numbers over the last few years, propelled this university into a higher stage of competitive development:

> *In Germany last year the compulsory attendance at school was reduced to 12 years with the consequence of twice as many new students at the university. For example, in the previous semesters we had about 41,000 students and nowadays 51,000 students … our basic funders have reacted by increasing the staff funding.*

Whereas the increase in student numbers has led to an expansion of the university's size, has an increase in research funding contributed to an increase in research output. Commenting on the development of research funding, Interviewee three stated:

> *In the last five years the number of academic staff has increased massively from 4,500 to 7,200 … [this] made possible by [a] generation of research funding. For five years we had about 80 Million whereas last year we generated just over 120 Million, about 80% of which is available for staffing costs. However, as result of the banking crisis of 2009 when looking back, we have indeed experienced that industry funding is significantly diminished, but over the last years we did manage to maintain our overall funding level. Despite increasing external research funding and accompanying apparent autonomy, the university is increasingly dependent on its governmental funders because the external funding is not sufficient to cover all indirect costs.*

The university now finds itself confronted with a loss of *Factor advantage*, stagnating student numbers and research income, and is falling-back on a strategy of preserving its competitive position. Here Interviewee three declares:

> *Because of the introduction of tuition fees over the last years, the number of teaching staff has expanded which also had an influence on research output. Tuition fees have again been withdrawn by the government, but were only partially compensated via an increase in basic funding. We are currently pursuing a more defensive strategy of focusing on and*

> *supporting our current strengths. New themes are being pursued, but selectively and with caution. Our latest uncertain endeavour was our Electrochemical Energy Technology Battery Research Centre which has been established for about 5 to 6 years. We are currently not taking many risks.*

In addition to this, internal factors have forced the university into its current state of competitive development. Here, Interviewee three highlights the cause of this prudent strategy:

> *This year and last the university went through a large savings operation because we overspent our budget by about 18 million. The savings were carried out so carefully that by the end of the year we had an underspend of 6 million. Through the savings operation, we have recognised that the sources of the overspending were the higher costs for enhanced infrastructure.*

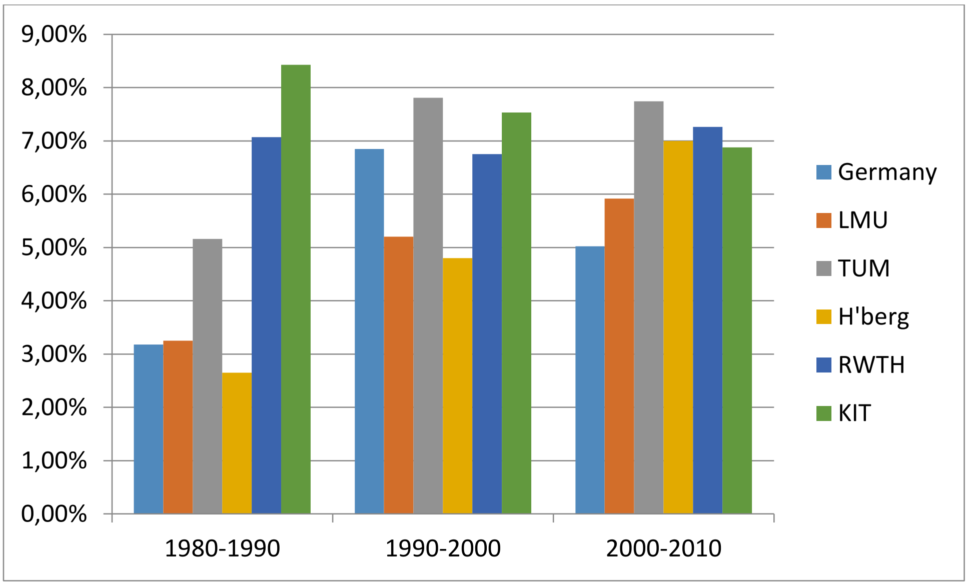
The narrative of Interviewee three clearly demonstrates that *Factor*-advantages alone are a too narrow a basis for sustained competitiveness, and investments in other preconditions to attain sustainable competitive upgrading are required (Porter, 1998, p. 552). This finding suggest that organisations have become immune to (Genteel-) Decline when: (1) A*dvanced-factors* are created and upgraded; (2) organisations develop global strategies; (3) international demand sophistication becomes an advantage; (4) a network of related and supporting organisations is in place - all these being characteristics of the *innovation-driven* stages (Porter, 1998, p. 553).

6.5.4 Immunity for (Genteel-)Decline

The percentages of increase in the research output of the top 5 German universities - these being measured by their number of papers published - range between a *Compound Annual Growth Rate* (CAGR) of 2.65% and 8.43%, with for the average elite university an increase of 5.31% in the 1980s and have increased to a range between 5.92% and 7.74%, with for the average elite university an increase of 6.95% in the 2000s. This being for the average elite university an increase of 31% between the 1980s and 2000s. The increase in research output of all German universities - these being measured by the number of papers published - shows a CAGR of 3.18% for the 1980s and an increase to 5.02% for the 2000s, an increase of 52% between the 1980s and 2000s.

A comparison between the increase in research output for all German universities with the increase of research output for the five elite universities in Germany, as shown in Figure 98, shows that each of the five German elite universities have not lost their competitive edge during the last three decades, but rather have strengthened it. Additionally, the share between elite universities and non-elite universities has remained stable, with a stable share for the five German elite universities of 14% over the last three decades.

Figure 95: Compound Annual Growth Rate (CAGR) of the increase in research output of five German elite universities

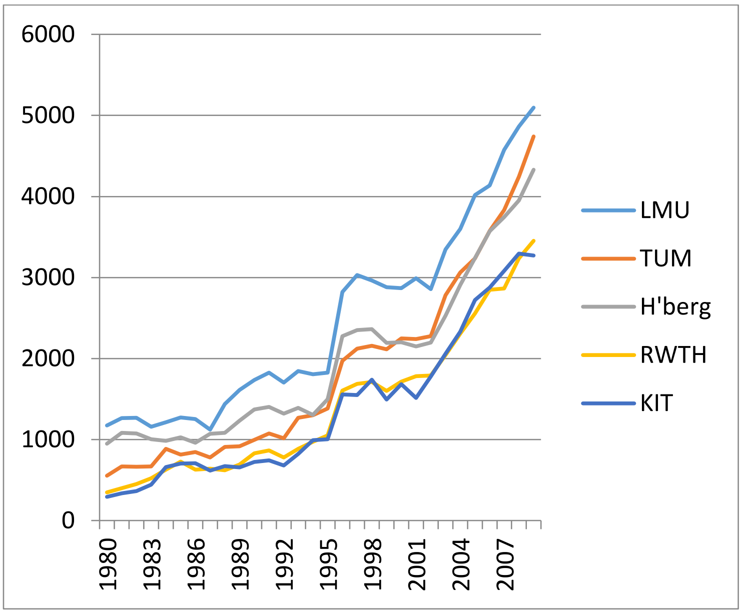


Scopus, no date.

As shown in Figure 98, in the 1980s one of the five German elite universities had a smaller increase in research output than the total of all the German universities, whereas in the 2000s all five German elite universities showed a greater increase in research output compared with the total number of all German universities.

The development of the research output for each of the five German elite universities is depicted in Figure 99.

Figure 96: The development of the research output of the five German elite universities



Scopus, no date.

Figure 99 shows for all elite universities an increase in research output until the mid-1990s, this being followed by a stagnation in the annual growth in the period mid-1990s to mid-2000s. The cause of this was the painful post-reunification restructuring and downsizing of the science system of the German Democratic Republic (DDR) and its integration into the science system of the German Federal Republic.

The findings as presented in this sub-section of the chapter demonstrate how no evidence has emerged of a (genteel-) decline in the research productivity of German elite universities over the last three decades and suggests that universities in the *innovation-driven* stage are immune to (Genteel-) decline. This can be explained by the self-reinforcement of the diamond in this stage of competitive development.

Table 57 shows the key characteristics of the wealth-*driven* / *Genteel-Decline* stage of competitive development as discussed in this section of the chapter

Table 57: Key characteristics of the *wealth-driven / Genteel-Decline* stage of competitive development

Name of stage:	**Decline**	**Decline**	**wealth-driven stage**	**Genteel-Decline stage**	**Disappearing spill over effects**	**Damaging scientific enterprise**	**Genteel-Decline stage**
Source:	No author, The Lancet (1897)	Kahn (1996)	Porter (1998)	Curran (2001)	Kim et al. (2009)	Stephan (2012)	This study
Country/Sector	Scotland/universities	German Science System	Denmark, Germany, Italy, Japan, Korea, Singapore, Sweden, Switzerland, UK, and US./trading nations	UK/Geography departments	US/economics and finance depts. of elite universities	US/health sciences departments	Germany/non-elite universities
Characteristics:	More aspiring youth prefer elite universities; poverty of career opportunities for graduates; graduation lacks prestige; excessive regional competition; overdone lecture system;	Poorly organised curricula; faculties and research labs show age; basic resources divided regardless of productivity; shrinking governmental budgets;	Shift from enhancing into preserving; declining investments; “stewards” replacing “entrepreneurs”; reduced risk-taking; underinvestment in innovativeness; motivation loss of work-force;	Competitive. strength based on staffing and facilities previously achieved; chronic under-investment; complacency and lack of competitive vitality; strategy, structure and rivalry	Spillovers from academic super stars disappear because of communication technology advancements; de-localisation collaborators; increased collaboration with non-elite university scientists;	Increased competition for senior faculties; high price of building boom; increased monitoring fund generating capability; lower success rates grant proposals; risk avoidance by researchers;	Loss of factor-advantages including student numbers and research funding; vulnerable to fluctuations in governmental funding; strategy of preserving rather than enhancing;

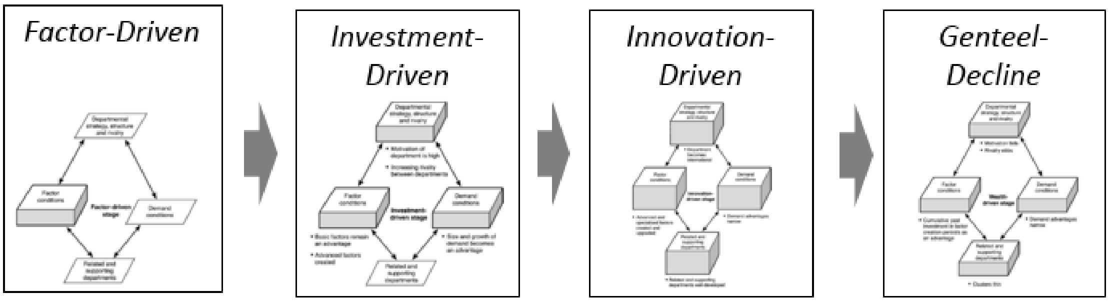
	inability to retain the best graduates.	suffocation of governmental regulations; loss of faculty morale and research power; “Brain drain” to non-university labs.	lessening prestige; diminishing factor-creation.	conditions as in the *factor-driven stage*.	increased competition for start scientists by non-elite universities; academic superstars make team members over-cautious and less productive.	little transformative research.	focus on achieved strengths; reduced risk-taking; diminishing industry funding; burden of overspending on infrastructure costs (building and energy); elite universities not involved

6.6 Summary of the Discussion of the Results of the Field Interviews Analysis and Presentation of the Model of Competitive Development of German universities

The summary of the discussion of the results of the field interviews analysis in this sub-section of the chapter together with the summary of the discussion of Porter’s thesis in the following Section 6.8 of this chapter forms the full resume of Chapter 6. The decision to summarise Chapter 6 in two sections is based on the consideration that Sections 6.2 to 6.5 discuss the empirical findings from the present research whereas the discussion in Section 6.7 is of a more theoretical nature.

In the Sections 6.2 to 6.5 of this chapter the characteristics and dynamics of each stage of competitive development of the performance in research of German universities are discussed; these have emerged from the field interviews and are discussed in the context of the extant literature. The discussion draws on Porter’s *Four stages of competitive development model* (Porter, 1998, p. 546) as presented in Figure 67. The model is used in the present study as a framework from which to abstract the stages of development of competitiveness generated by research of German universities. As shown in Figure 100, the *Four stages of competitive development* model has a relationship with Porter’s diamond model in that each of the four stages corresponds with a distinct configuration of the diamond.

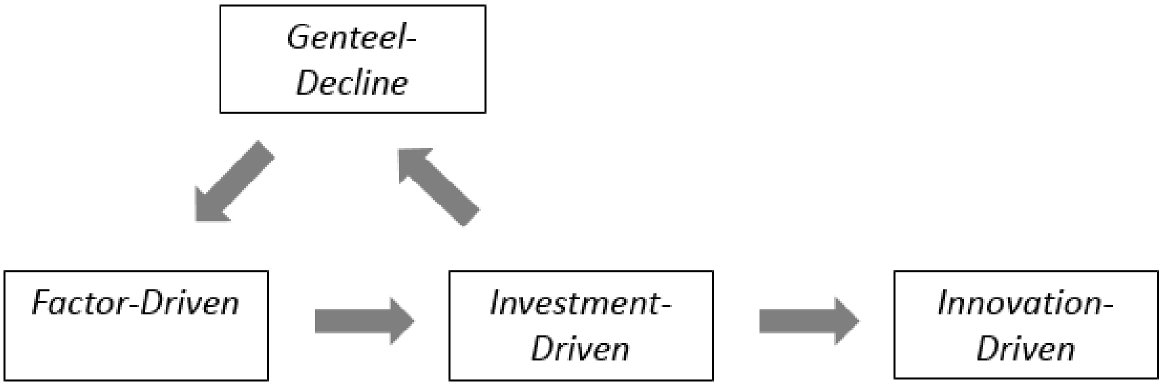
Figure 97: Relationship between Porter’s Four stages of competitive development model and the diamond model



Derived from Curran, 2001, p. 247.

The findings from the present research are congruent with Porter (1998, p. 545) since it is not inevitable that all the stages are passed through and no particular situation will fit a stage exactly. However, evidence of "… complacency, lack of competitive vitality and an increasing emphasis on the redistribution rather the creation of wealth", these being listed by Curran (2001, p. 248) as characteristics of the *wealth-driven stage*, do not emerge from the field interviews. Furthermore, the positioning of the *Genteel-decline* stage after the *innovation-driven stage* in Porter's model suggests that institutions in the *Genteel-decline* stage have first entered the *innovation-driven stage* with the full diamond in place, but this is contradicted by the findings of this study. As discussed in Section 6.5 of this chapter, the findings of this study show that universities found in the stage of *Genteel-Decline* were first propelled by favourable factor conditions from the *factor-driven* stage into the *investment-driven* stage and are now in the *Genteel-Decline* stage without having reached the *innovation-driven stage.* To faithfully depict the stages of competitive development in German higher education requires Porter's model adaptation, as shown in Figure 101.

Figure 98: The four stages of competitive development of German universities



The key features of each stage of competitive development emerging from the present study are summarised in Table 58. As highlighted in the Introduction section of this chapter, there are numerous factors that contribute to competitive advantage and international success and is it inevitable that some of these are not included in Table 58. Despite this caveat, the aim of the table is to highlight the most important topics of each stage so that they inform university decision makers about how the competitiveness of universities develops, the characteristics of each stage of competitive development and the forces that propel upgrading.

Table 58: Key features of the four stages of competitive development.

Factor-driven **stage**	***Investment-driven*** **stage**	***Innovation-driven*** **stage**	***Genteel-decline*** **stage**
Research focus is the result of historic developments; largely dependent on governmental funding; economic downturn negatively affects the success rate of grant applications; additional institutional funding of grant funded research is required;	Benchmarking not employed enough as a basis for profile development; profile development through *Focused differentiation* strategy; full exploration of underserved research areas with strong positions is lacking; threshold critical mass of students,	Exploiting favourable historically developed orientation; (international) collaboration key component of university strategy; pursuance of international and interfaculty collaboration; wide array of extra-institutional partners;	Loss of factor-advantages including student numbers and research funding; vulnerability to fluctuations in governmental funding; strategy of preserving rather than enhancing; focus on achieved strengths; reduced risk-taking;

positive factor conditions may comprise: the presence of industry, a pleasant working and living environment, the availability of real estate for research institutes, the presence of national research institutes;	researchers and funding essential for upgrading; size determines opportunities for upgrading; limited opportunities for growth with size mostly the result of historical growth; positive relationship between size and performance; current funding practices create "Matthew effect"; dualistic structure of governmental funding limits opportunities for upgrading; essential context for entrepreneurial university appears to be missing; factors affecting performance form a causal chain; funding largely determined by supposed quality of faculty; upgrading from *Basic factor*s into *Advanced factors.*	focus on world-class collaborators sustains self-reinforcement; positive relationship between collaborations and impact; creation of remote joint-institutes; immediacy to industry featured with focus on feasibility, market needs and cooperation; collaboration with nation-wide research organisations; international recruitment; reduced governmental dependence.	diminishing industry funding; burden of overspending on infrastructure costs (building and energy); elite universities not involved

The conclusion emerging from the discussion in the previous sections of the chapter is that the diamond and the adapted *Four stages of competitive development* model together provide an elucidating view of the competitive condition of German universities and this directly informs the research question mentioned in the introduction of this chapter. A discussion about Porter's thesis in a theoretical context ends this chapter with a more detailed discussion about the foundations of his thesis being provided in the next section.

CHAPTER 7: THE CONCLUSION

7.1 Introduction

This chapter comprises several elements. It begins with a reflection on the aims and objectives of the research (Section 7.2). This is then followed by an exploration of the main research findings and insights into existing theoretical and empirical research (Section 7.3). The contribution played by the present research in terms of adding to the pool of knowledge is expanded upon in Section 7.4. Section 7.5 reflects the limitations of the study and is followed by a presentation of the recommendations and implications for professional practice in Section 7.6. The chapter ends by signposting possible areas of future research in Section 7.7 and Final Conclusions and Remarks in Section 7.8.

7.2 Reflection on the Aims and Objectives of the Research

The aim and objectives of the present research drew on the research question as mentioned for the first time in Section 1.2 of this thesis:

> *Can we employ a broad framework, well embedded in the management literature which explains the impact of the determinants on university competitive advantage as generated by research and one which helps make understandable the dynamic process by which university competitive advantage generated by research is created and upgrading*

is enabled so that university policy makers' strategic objectives can be more effectively met?

and comprise the identification and adaptation of a theoretical framework explaining the environment in which universities compete and helping to understand why some universities perform better than others (see Section 1.4).

The scope of the present research was limited to German universities. This country was chosen because it was the working location of the author and the place where the results could contribute directly to the author's professional practice. The direction of this journey was largely determined by the consideration that when universities are viewed as corporate enterprises (Jarratt, 1985) an investigation into the performance of universities should begin with the exploration of the lessons to be learned from the corporate sector, thus this study aims to contribute to the paucity of performance assessment in higher education literature which take management practices into consideration. The objectives of the review of performance measurement in the corporate sector literature (Section 2.3) drew on this consideration and the intended contribution to knowledge of this study and comprise the following themes: (1) learning how performance measurement has developed in the corporate sector; (2) identifying a framework that can be used in the higher education sector; (3) looking for congruence between developments in the corporate sector and those in the higher education sector.

The selection of Porter's diamond and the accompanying *Four stages of competitive development* models was based on the consideration that Porter is one of the world's best known business academics (Davies and Ellis, 2000, p. 1189) and has claimed that his thesis explains the sources of sustained prosperity (Porter, 1998, p. xi). In addition, his models were successfully used in UK higher education (Curran, 2001).

Quantitative archival data was collected and examined for relevance to assess the competitive condition of each of the corners of the diamonds of German universities (see the results in Chapter 4). This was followed by the collection of qualitative data from interviews held with a purposive sample of four German universities in order to see whether there was congruence with Porter's thesis with regard to how competitiveness develops (see results presented in Chapter 4).

The outcomes of these examinations led to the emergence of four multiple regression equations and an adapted version of Porter's diamond model which made it possible to estimate the performance of German universities vis-à-vis their peers (see a discussion about the findings in Chapter 5) as well as to an adapted version of Porter's *Four stages of competitive development* model (see discussion of the findings in Chapter 6). The importance of these findings for professional practice is that the two models enable university policy makers to assess the competitive condition of their universities and to understand the dynamics of development and the upgrading of competitive advantage, so addressing the research question referred to earlier in this sub-section of the chapter.

The strength of the research question was born out during the research as a number of issues contributing to knowledge emerged as the result of the study.

It was found in Section 2.3.1 and 2.3.2 that the key themes, arguments, assumptions and conclusions emerging from review of the literature on frameworks and measures all involve the *relationships* between the measures included in the frameworks and performance, highlighting the pivotal role of these relationships. From the review of the literature further implications emerged for professional practice as it became apparent that incorrect assumptions about the *relationships* between measures and performance jeopardises the attainment of strategic goals and that use of the *wrong* measures could provide meaningless data or drive dysfunctional behaviour.

It was also found that the fundamentals of the frameworks themselves have changed little since their development at the beginning of the 20th century, but that the measures included in the frameworks have developed in the second half of the 20th century from *single measures* into more complex or *balanced measures*.

It was found in Section 2.4.1 and 2.4.2 that in higher education an RAE-type peer review has developed into the archetype assessment method. However, the costly and time consuming panel system of this approach has driven the emergence of the analysis of quantitative (bibliometric) indicators as an alternative assessment method. Here, it emerged that the use of quantitative output measures overcomes personal bias of peer reviewers and allows the recognition of macro patterns. Nevertheless, despite their apparent advantages output related assessments should be supplemented with intensive case studies.

The extant literature reviewed in Chapter 2 further provided evidence that the outcomes of the RAE-type peer review assessments provide reasonable and realistic outcomes and also provided evidence of a strong correlation between the outcomes of RAE-type assessments and rankings based on analysis of quantitative (bibliometric) indicators.

Whereas congruence was found between the outcomes of qualitative RAE-type assessments and the employment of frameworks and quantitative measures should not be forgotten that many of the employed frameworks are based on an immature understanding of the relationships between the attributes measured and performance (Neely, 2005, pp. 1271-1272).

Based on the evidence that emerged from the review of the literature it can be concluded that the aims and objectives of the present study are to provide an important contribution to professional practice in higher education management, especially if the identified theoretical framework is embedded in the extant management literature and supported by rich empirical evidence. As part of the reflections on the research question, the challenges and limitations of the study are explored later in this chapter.

7.3 Exploration of the Main Research Findings and Insights into Existing Theoretical and Empirical Research

The present research was aiming to build on the limited extant literature concerning performance measurement in higher education, hereby drawing on theories from the economic and management literature for the purpose to increase the understanding of the development of competitive advantage in higher education. This research has identified two knowledge gaps: (1) the absence of a universal method to assess the condition and impact of research; (2) the fact that universities often lack the knowledge and expertise to perform these evaluations (Barnabe and Riccaboni, 2007, p. 307). Further, the emerging imperfect state of knowledge about what measures to use (Feller, 2002) became one of the focus points of the present research. The context of the present research was found in a large number of sources and included a significant amount of rarely cited papers; this being an indication of a “relative immature field of academic study which has relatively little consensus about its core theoretical foundations” (Neely, 2005, p. 1267).

The major contributions to existing knowledge made by the present research which directly inform the research question are:

- The use of the modified version of the diamond model as presented in Figure 84 makes it possible to realistically assess and determine the stage of competitive development of German universities;
- The use of the modified version of Porter’s *Four stages of competitive development* model as presented in Figure 101 facilitates a realistic understanding of the characteristics of each stage and the dynamics between the stages;
- The use of the modified versions of Porters two mo*dels* explains the impact of the determinants on university competitive advantage generated by research and helps to understand the dynamic process by which this advantage is created and upgrading is enabled, so that university policy makers’ strategic objectives can be more effectively met.

These contributions answer the research question formulated in this this study.

7.4 Summary of the Key Findings of the Present Research

7.4.1 Summary of the Key Findings of the Present Research in Chapter 1

The aim of Chapter 1 was to establish the boundaries of the present research and to determine the context and significance of the study by drawing on emerging *gaps in the literature*. In addition this chapter aimed to capture the purpose of the study via the formulation of the principal research question.

The contribution to knowledge in Chapter 1 was made by showing that after the significant status of performance evaluation and quality assurance in higher education was formalised in the 1990s (Bessette, 2003, pp. 355 - 356 and European Ministers of Education, 1999, no page) an increased interest in and application of evaluation methodologies materialised from which two knowledge gaps emerged: (1) the absence of a universal method to assess the condition and impact of research; (2) the lack of knowledge and expertise to perform these evaluations (Barnabe and Riccaboni, 2007, p. 307).

In the present study was further found that the RAE/REF-type explicit and large scale peer assessments of university performance that had become ubiquitous in the UK and in many other European countries, proved time consuming and expensive leading to attempts to substitute qualitative peer evaluation with quantitative determinants (bibliometrics[36]) (Broadbent, 2010, p. 19).

In addition it emerged from the study that most of the methods derived from the management literature used to evaluate research performance in the higher education sector, such as Total Quality Management (TQM) (Tambi, Ghazali and Yahya, 2008, p. 1005) and the calculation of Return On Investment (ROI) did not do justice to the impact of science, this ranging from knowledge and technology to economic growth and job creation (Lane, 2009, p. 1275).

[36] Bibliometrics = "the application of mathematics and statistical methods to books and other media of communication" (Pritchard, 1969, p. 349).

7.4.2 Summary of the Key Findings of the Present Research in Chapter 2

The aim of Chapter 2 was to provide an overview of the sources explored and to position the research within a larger domain of study, with underlying objectives including the identification of key variables, methodologies and approaches and the identification of theoretical foundations. For this purpose this chapter first provided a review of the body of literature pertinent to the corporate sector, followed by a review of the literature relevant to the higher education sector.

The contribution to knowledge about key variables, methodologies and approaches in this chapter showed that one of the earliest and most important methodological approaches in performance evaluation is the development in the 1920s of the Du Pont pyramid of financial ratios which introduced the Return On Investment (ROI) ratio as a measure of financial performance. This framework provides the basis from which virtually all modern performance reporting and evaluation systems have been developed (Kaplan, 1984, pp. 396, 398-399). Similarly, the Tableau de Bord (= dashboard) developed in France in 1932 became the archetype of the performance measurement systems that have been developed since. Following these developments in the early 1900s there were no major innovations in methodological approaches for many decades (Neely, Gregory and Platts, 1995, p.89). It was further found that the universal applicability and transparency of financial performance measures (for example ROI) are the reasons for their enduring dominance in performance measurement systems (Chandler, 1990, p. 139).

From the review of the literature it further emerged that the first time research performance was assessed in the UK the sector learned that there are no simple measures of research performance - only a set of *partial indicators* yields reliable results (Martin and Irvin, 1983, p. 61).

The review of the methodological context of performance measurement in higher education in this chapter showed that alongside the RAE/REF-type research assessments, only a few additional performance evaluation systems emerged, most having a modest impact (Glass, Hyndman and McKillop, 1996), with the exception of a generic approach derived from the management literature: Porter's seminal diamond model. This model is successfully used to assess the competitive strength of UK geography departments according to four broad attributes which together shape the environment in which the departments compete (Curran, 2001).

In Chapter 2 was also highlighted that as regards the dominance of the bibliometric indicators used in the research evaluation literature, it is acknowledged that these "… have moved from the niches of academia into a strategic position in policy making … [where] … questions of validity and reliability, theoretical foundation and quality of data …" remain unanswered (Weingart, 2005, p. 130).

The contribution to knowledge about the theoretical foundations in this chapter showed that the theoretical context of measuring performance dates back to the thesis of Lord Kelvin in the late 19th century where learning is rooted in numerical reckoning and methods for measuring (Paul, 2008, p. 325). The assumptions on which the measurement of performance was introduced into the public sector included the following considerations: (1) the public sector is underperforming because of poor management; (2) core management functions are applicable across different sectors, including the public sector; (3) measuring performance will lead to improvements (Adcroft and Willis, 2005, p. 389). However, there is a scarcity of evidence in the literature for these assumptions (Glass, Hyndman and McKillop, 1996, p. 59).

The body of performance measurement papers in the business, management and accounting literature comprised by the time of writing this thesis 2,865 papers out of which 94% have been published since 1995 (Scopus, no date). The literature was found to have been published in a large number of sources and included a large amount of rarely cited papers, this being an indication of a "relative immature field of academic study which has relatively little consensus about its core theoretical foundations" (Neely, 2005, p. 1267).

7.4.3 Summary of the Key Findings of the Present Research in Chapter 3

The aim of Chapter 3 was to describe the rationale for the methodology employed to identify, collect and analyse the information used in order to answer the research question and to allow the reader to critically evaluate the present research overall validity and reliability. The chapter provided a detailed discussion of all elements of the research design.

The contribution to knowledge about the choices made in this chapter relevant to the research design highlighted that the chosen research design had a clear connection to both the quantitative and qualitative aspects of the research question by which the empirical-analytical approach to test the hypotheses related to the relationship between quantitative measures and performance was conducted through deductive reasoning and the use of statistical methods similar to those common in the natural sciences. To develop a comprehensive and holistic understanding of the process of development and upgrading of competitive advantage were inductive reasoning and abductive methods chosen which made it possible to analytically disclose the meaning-making practices which took place. To integrate the quantitative and qualitative research within one single approach the paradigm of *Mixed methods research* was employed. The paradigmatic and methodological approaches which facilitated the exploration of the applicability of Porter's diamond framework as well as his *Four stages of competitive development* model in German higher education in this study are summarised in Table .

7.4.4 Summary of the Key Findings of the Present Research in Chapter 4

The aim of Chapter 4 was to provide the findings of the present research in a logical sequence according to the research design presented in Chapter 3. The objective of this approach was to portray the real-life conditions of competitive advantage generated by research of the German universities in the sample used in this study and to portray the process of development and upgrading of their competitiveness. In this chapter the research findings, comprising qualitative and quantitative data, were presented without bias or interpretation – hypotheses were merely confirmed or rejected.

The contribution to knowledge of the quantitative sections of this chapter were made by the outcome of an evaluation of 15 institutional variables which could serve as a measure of each of the four corners of the diamond. Relationships with performance were evaluated by testing hypotheses using bivariate and multivariate analyse techniques made available with SPSS.

All graphs but one (Figure 48=SciVal subject areas) being the outcome of the 15 variables subjected to descriptive statistical methods to understand what they meant at a superficial level, showed positively skewed frequency distributions, indicating that the highest frequencies were found for the smallest universities. The outcomes of a *K*-means cluster analysis further identified 3 different clusters in the sample of German universities in this study.

Chapter 4 also highlighted that the outcome of Stepwise Multiple Regression Analyses, carried out to calculate regression equations to estimate the condition of each of the four corners of the diamond for all the universities in the sample, showed the disappearance of 7 of the 15 tested indicators since their coefficient became non-significant due to the effect of the other tested indicators. The four regression equations (Tables 31, 36, 41 and 46) including eight remaining indicators (all income; total library expenditure; ratio of papers to all staff; ratio of total income to all staff; academic staff; SciVal subject areas; total authors; all staff) showed that the most explained variance was found with the *corner Strategy, structure and rivalry* conditions.

The contribution to knowledge of the qualitative sections of the chapter comprised the results of the application of *thematic analysis* (Braun and Clarke, 2006, p. 82) to capture important topics in the interview data in relation to the research question and to identify the characteristics of each stage of competitive development.

The contribution to knowledge from the analysis of universities in the *factor-driven* stage revealed two overarching themes: *Research excellence,* rooted in the historically grown size and present financial and research strength and propelled by the presence of nationwide research institutes such as Max Planck, Fraunhofer, Helmholz, etc. and *Funding,* the latter rooted in the nation's financial prosperity and the university's balance between Natural sciences and Arts & Humanities. It was found that opportunities for upgrading in this stage are largely determined by the government, which role is substantial (Section 4.3.1).

The contribution to knowledge from the analysis of universities in the *investment-driven* stage revealed two overarching themes: *Operationalisation* and *Strategy*. The strategy theme comprised *governmental influence*, *focus on strengths* and *professionalization*. The *governmental influence* in this stage emerged as paradoxical: encouraging the upgrading of competitiveness via for example Excellence initiatives but at the same time controlling the opportunities for appointing tenured professors. It was also found that universities at this stage draw on their own resources for the initial investment to upgrade by which the opportunities for upgrading were very much determined by the universities' size. Here, it was acknowledged that universities below a certain *critical mass* could not pursue innovation, hence departments that could not reach a *critical mass* alone chose to collaborate with other departments outside their own discipline or at other universities (Section 4.3.2).

The contribution to knowledge from the analysis of universities in the *Genteel-decline* stage revealed one overarching theme: *Sustaining strength,* drawing on the *causes of discontinued growth* and the *opportunities for compensation.* Emerging *causes of discontinued growth* include lagging student numbers and government funding, whereas emerging *opportunities for compensation* include the exploitation of industry research and of unexplored opportunities in the Arts & Humanities (see Section 4.3.4).

The contribution to knowledge from the analysis of universities in the *innovation-driven* stage revealed one overarching theme: *Scale effects*, drawing on 4 themes: *internal supporting departments, interfaculty research collaboration, international research collaboration* and *focussed differentiation* strategy.

7.4.5 Summary of the Key Findings of the Present Research in Chapter 5

The aim of chapter 5 was to present an interpretation of the main findings, to demonstrate why these had relevance for the research question, to relate them to similar studies, to explain how these findings have moved our understanding of the research problem forward. The chapter was divided into four sections, each discussing a corner of the diamond, as well as an introductory and concluding section.

Contributions to knowledge in this section of the chapter were made with a discussion of the determinants of *Ability related conditions*. The testing of the determinants of this *corne*r revealed that the dynamics of the relationship between the determinants and performance was characteristic for a '*chicken and egg' causality dilemma* where modest performing universities experienced difficulties generating the essential means to upgrade. It was found that this finding is better explained by Wallerstein's (1976, pp. 229-233) *Modern World-System centre-periphery theory* than by differences in the abilities of German researchers or by Porter's thesis, the latter maintaining that this corner creates advantages through economies of scale by influencing "the rate and character of improvement and innovation" (Porter, 1998, p. 86). These findings disclosed that differences occur between the corporate sector, as captured in Porter's thesis, and the higher education sector (in some countries) as examined in the present research.

The contributions to knowledge of testing the determinants of the corner *Collaborator and role model conditions* were all connected to Porter's thesis and Wallerstein's theory. Here, the findings of this study that the size of the institution and the breadth of the research portfolio determine its performance is explained by Porter's thesis concerning the impact of *linkages* highlighting that the largest competitive advantages are generated from collaborations with equally international successful collaborators that are situated within close proximity and share a cultural similarity (Porter, 1985, p. 48 and 1998, p. 103-104). Porter's thesis draws on Wallerstein's *Modern World-System* theory which maintains that "tasks requiring higher skill levels and greater capitalisation are reserved for higher-ranking areas … [and] … involves a strong trend toward self-maintenance … [and] … makes it very difficult to intrude counteracting forces" (Wallerstein, 1976, p. 230).

7.4.6 Summary of the Key Findings of the Present Research in Chapter 6

The aim of chapter 6 was to provide a framework for interpreting the qualitative findings presented in Chapter 4 for the purpose of enhancing our understanding of the dynamics of the development of university competitiveness generated by research and to put forward an adaptation of Porter's *Four stages of competitive development* model (Porter, 1998, p. 546) that contributes to answering the research question. The chapter was divided into four sections, each discussing a stage of competitive development, as well as an introductory and concluding section and the chapter concluded with a discussion of Porter's thesis.

The contribution to knowledge of this chapter included a presentation of the organisational context of the *factor-driven* stage. It was found that universities in this stage drew all their advantage from historical and / or geographical circumstances. Additionally was found that the absence of essential funding to upgrade into more sophisticated segments and / or to upgrade skill levels was the main reason why many universities never moved beyond this stage.

As regards to the *investment-driven* stage it was revealed that all the key activities in this stage were related to reaching a *critical mass* or a further increase in size by which collaborations played a pivotal role. Here, the introduction of benchmarking to inform initial profile development is depicted by the emergence of the corner *Strategy, structure and rivalry* conditions in the diamond, whereas the introduction of a strategy of first deepening and later widening of existing research areas for this purpose, is depicted by the emergence of the *corner Ability related conditions.* The impact of an increase in size was in this chapter explained at hand of the long-run cost behaviour which could be depicted as an S-shaped curve, first showing diminishing marginal utility followed by a recurrence of declining costs. This finding is congruent with very early research of long-run cost behaviour in higher education and can be explained in the context of classical microeconomic economies of scale (Maynard, 1971, pp. 88-89). In addition were in this chapter also differences in the entrepreneurial freedom between German and UK universities discussed, which could be explained by Olsen's (1988, pp. 233-254) *Four state steering model* which highlights how universities operating in an *institutional state* model as in Germany, experience considerable academic freedom but are limited in their expansion by governmental arrangements, whereas universities operating in a *supermarket model* as in the U.K. enjoy more entrepreneurial freedom.

As regards to the *innovation-driven* stage it was found that this stage is unique in the self-reinforcement of its *full* diamond, which can be explained by Wallerstein's (1976, pp. 229-233) *centre-periphery* theory (see Section 5.4). The analyses of the *innovation-driven* stage showed congruence with the analysis of the *investment-driven* stage earlier in this chapter in that both revealed the pivotal role of collaboration as an enabler of innovation and upgrading, this being congruent with previous research findings where for example a positive correlation was found between the number of collaborators and the impact of new knowledge (Benavent-Perez, Gorraiz, and Gumpenberger, 2012, pp. 53-54). Within this context is it therefore surprising that there was little found in the literature about the role of collaboration among peers in order to encourage the creation of new knowledge (Azoulay, Zivin and Wang,2010, p. 550).

As regards to the *Genteel-decline* stage this chapter found that universities in the *Genteel-decline* stage were first propelled by favourable *factor* conditions into the *investment-driven* stage – proving the competitive vitality of the universities - and dropped back into the *factor-driven* stage when the factor advantages ceased to exist, without having reached the *innovation-driven* stage as Porter's model suggests (Porter, 1998, pp. 556-560).

The contribution to theory in this chapter is the adaption of Porter's *Four stages of competitive development* model, depicting the *factor-driven,* the *investment-driven* and the *Genteel-decline* stages in a triangle rather than in a straight line. Since Germany's elite universities in the *innovation-driven* stage proved immune to a transfer into the *Genteel-decline* stage and because of their *self-reinforcement*, the *innovation-driven* stage as depicted in the adapted model is on a straight line following the *factor-driven* stage and the *investment-driven* stage, but outside the triangle, as portrayed in Figure 101.

7.4.7. Resume of the theoretical/practical contributions of the thesis

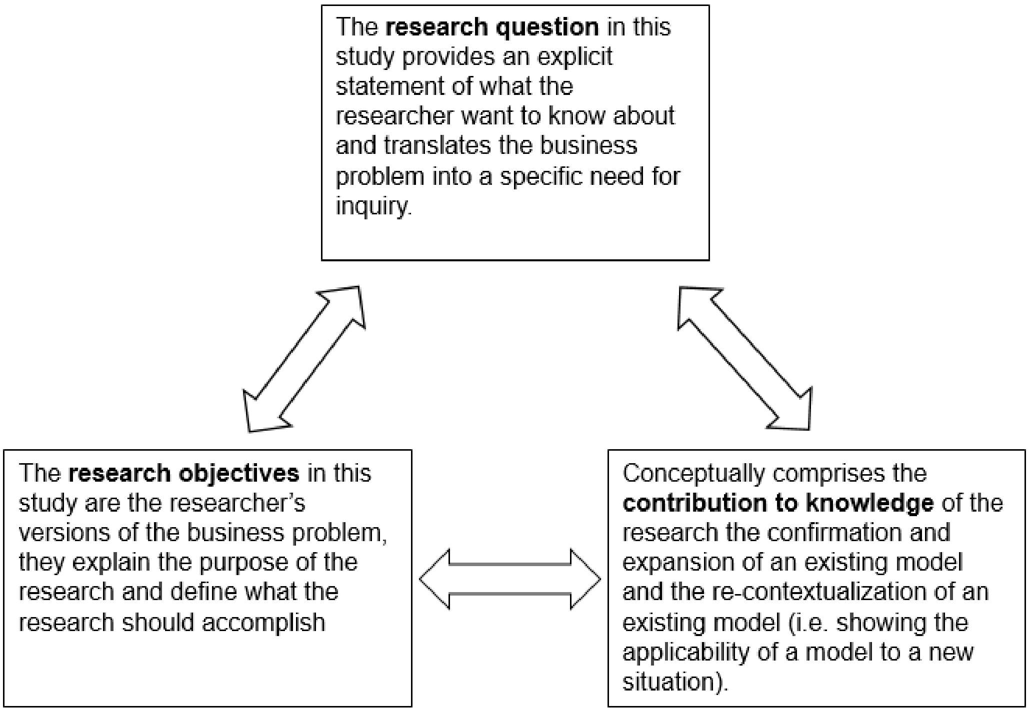
The aim of this research was to explore and enhance what is known about the impact of the context in which universities compete for competitive advantage generated by research. Additionally, the thesis also endeavours to provide further insight into why some universities perform better than others and thereby to contribute to the research field of performance measurement, specifically in the public/higher education sector.

While the predominant focus of the research was to make a contribution to professional practice, a contribution was also made to theory when the research was operationalised. This contribution included adapted versions of Porter's diamond and the four stages of the competitive development model. These conceptual frameworks, supplementing the discussion and presentation of the research findings, are held to be contributions to knowledge in their own right. Further, the additions to knowledge in this study integrate theory and empirical practice into a middle-range theory so compensating for the paucity of theoretical models. It is therefore argued that this thesis makes both a contribution to professional practice and to theory.

This contribution has further increased salience within the present research as the adapted versions of Porter's models can be aligned to the main propositions of modern measurement theory. This is specifically the case as regards the relationship between the (attributes of the) object to be measured and its measurements or indicators, as depicted in the conceptual model for measuring research performance in higher education in Section 2.5.

A conceptual presentation of the links between the initial research question, the objectives of the study and the outcomes of the research is depicted in Figure 99.

Figure 99: Conceptual presentation of the links between the initial research question, the objectives of the study and the outcomes of the research



The tabular presentation of the theoretical and practical research contributions in relation to the research objectives of this study, as shown in Table 59, aligns with Table 1 in Section 1.6 and comprises a summary of the key findings of this study as presented in the previous Sections 7.4.1 to 7.4.6.

Table 59: Theoretical and practical research contributions in relation to the research objectives of this study

Area	**Planned key contribution**	**Contribution**	**Conceptual framework**
Method and practice	Learn from different research domains and introduce this knowledge into the higher education domain.	Contributes to knowledge and practice by identifying two knowledge gaps: the absence of a universal performance assessment method and a lack of knowledge and expertise in higher education to carry out performance evaluations.	
	Identify the key measurements of university performance and explain their impact.	Contributes to methods with an adapted diamond model to realistically assess and determine the condition of competitive development in universities.	The modified version of the diamond model, as shown in Figure 84.
	Improve the understanding of how university performance in research is created and develops to improve the attainment of universities’ strategic goals.	Contributes to methods with an adapted *Four stages of competitive development* model to understand the characteristics of each stage of competitive development and the dynamics between the stages.	The modified version of the *Four stages of competitive development* model diamond model, as shown in

			Figure 101.
	Make a contribution to professional practice with a practical solution for the research problem.	Makes an incremental advance in methods, taking management practices into consideration by using adaptations of Porter’s models as a practical solution to enable university policy makers to meet strategic objectives more effectively.	
Theory and practice	Provide (a) theoretical framework(s) for university performance.	Contributes to theory by identifying how many frameworks draw on an immature understanding of the relationship between performance and its measures or indicators that results in the provision of meaningless data, the emergence of dysfunctional behaviour and the failure to reach strategic goals.	
		Contributes to theory by aligning adapted versions of Porter’s models with the main propositions of modern measurement theory.	

7.5 Limitations of the Study

The aim of outlining the limitations of the study in this section of the chapter is to provide recognition of the limitations of the present research, to offer an understanding why such factors are limitations, and to point to measures which were taken to combat these limitations.

7.5.1 Robustness of the Data

The collected archival data from publicly available sources included in this study is the *best-available* data. For a relatively large number of the German universities not all the data and / or not all the data from the same year could be retrieved because many universities did not (timely) publish an Annual Report or a similar publication. Additionally, inconsistencies in the included modalities, for example whether an academic hospital should be included with an university or not, the different modalities of research funding and the use of different definitions of staff members, may have had an influence on the robustness of the data used. However, as the robustness of the quantitative data used in the present research did not differ significantly from the robustness of the widely used bibliometric data in research performance studies, it is assumed that minor deviations due to the lack of robustness of the data did not have a significant impact on the outcomes.

7.5.2 Interviewer Bias

Since the collection of the qualitative data from semi-structured interviews involved the interaction between the interviewee and researcher, a different interviewer asking the same broad questions may have received different answers and might have responded differently to the answers received, so that the interview could have moved in a different direction. It should also be acknowledged that the interviews represent snapshots in time.

7.5.3 Purposive Sampling, sample size

Within the context of quantitative research the size of the sample used for the interviews would negatively impact the sampling error and reliability of the outcomes. However, within the context of qualitative research the purposive sampling of the cases in the present research was similar to most sampling in qualitative research (Bryman, 2012, p. 418). Here, the sampling was conducted with reference to the goals of the study: to ensure that sample members differed maximally from each other in terms of stage of competitive development. This non-probability method was chosen because it would have been impossible or very costly to include all German universities in the study (Blaikie, 2010, p. 178). The selection of the cases has been a matter of judgement as to which cases would be most appropriate, and cases were included in the sample to facilitate the development of the emerging theory about the competitive development of German universities. The addition of cases to the sample was stopped at the point where nothing additional of significance had been discovered.

7.5.4 Interpretitive Approach

The Interpretitive approach of the present study also had its impact on the findings of the research. It should be acknowledged that the findings of the current research are the result of the author’s constructions which are likely to be open to different interpretations, but they are congruent with the constructivistic and interpretivistic approach chosen in the research. In adhering to such an approach the present study was seeking “… to establish and objective science of the subjective, with the aim of producing verifiable knowledge…” (Blaikie, 2010, p.99).

7.6 Implications for methods, professional practice and theory

Universities today are confronted with worldwide competition for funding, researchers and students. In response, universities must (learn how to) compete globally. Their size and financial and research strength underpinned by governmental support shape their capacity to innovate and upgrade. The following sections offer contributions to practice made by this work.

7.6.1 Mind Shift at Institutional and Managerial Level

The implications of the findings from the present study for professional practice could be manifold and may involve at some institutions a *mind shift* at institutional and managerial level. Such a *mind shift* results in:

- University decision makers aiming at making the best advantage of their *factor advantages* and overcoming organisational inertia;
- Universities exposing themselves to global competition and stimuli that motivate and guide their upgrading;
- University decision makers creating a context in which upgrading of specialised skills and assets as well as enduring change is viewed as normal;
- Universities and researchers together establishing and strengthening international collaborations with research centres and sources of the most talented people to create economies of scale or learning.

7.6.2 Creation and Upgrading of Factors via Collaboration

The findings of the present study clearly demonstrate that the level of competitiveness a university can achieve is determined by the quantity and quality of its *factors*, the latter including highly skilled staff and scientific expertise. For the upgrading of its *factors*, direct investments must be made into training of research staff and infrastructure.

One of the key findings from this study is the pivotal role of collaboration to achieve *factor creation and upgrading* – increasing and upgrading the pool of factors from which each collaborator draws. Universities should not only influence *factor creation and upgrading* through collaboration with other universities and research institutes but also through collaborations with industry. This study provides the evidence that a high level of participation in collaborations is typical for elite universities in the *innovation-driven* stage. Universities should use these elite universities as role models and play an active role in the formation of such collaborations.

7.6.3 Compelling Simplicity of the Models

The findings of the present research, including the adapted versions of Porter's diamond and *Four stages of competitive development* models, facilitate an explanation and an understanding of the role and impact of the determinants of research performance. They are of a compelling simplicity which by far outnumbers the critique on Porter's models as discussed in Section 6.7 and the limitations of the present research in the previous Section 7.5. Together with university leadership that believes in change can the findings of this study energise institutions to create and upgrade their competitiveness, improve their competitive environment and encourage appropriate government policies.

7.7 Areas for Future Research

From the findings of the present research together with their contributions to knowledge a number of potential research opportunities emerged.

7.7.1 Exploration of the Theoretical Assumptions

It emerged from the identified paucity of literature on the theoretical foundations of performance measurement systems that the underpinning assumptions of these systems had not been fully explored or well understood (Neely, 2005, p. 1267). Further research should be carried out into the empirical investigation of performance measure frameworks, including a detailed examination of the underlying assumptions, and this should be followed by a theoretical validation.

7.7.2 Investigation into Differences between German and UK Higher Education

The modest amount of explained variance between the indicators of the corner *Ability related conditions* and performance in this study could be explained by the assumption that there were no significant differences in the abilities of the German researchers whatever the reputation of their university - a finding that emerged from the interviews. However, earlier research in UK higher education showed a much higher amount of explained variance. It is therefore recommended that possible differences between scores on *the ability to secure research income, to attract and support people and to publish* between German and UK higher education should be examined in more detail in future research.

7.7.3 Further Investigation into the Role of Collaboration Among Peers

The contribution to knowledge in the present research has increased understanding of the pivotal role of collaboration in the development and upgrading of competitiveness in research. However, the present research also showed that little is known about the role of collaboration among peers to propel the creation of new knowledge. This offers opportunities for future research.

7.7.4 Further Investigation into the Differences between the Higher Education Sector in the UK and in Germany

Curran characterises UK universities in the *wealth-driven* stage by "… complacency, lack of competitive vitality and an increasing emphasis on the redistribution rather than the creation of wealth" (Curran, 2001, p. 248). However, these characteristics do not emerge from the interviews. Whereas, the absence of complacency and lack of competitive vitality at German universities is explained by the concept of *values* which differ in the higher education sector from those in the private sector, this explanation does not explain the differences between the higher education sector in the UK and in Germany and hence further research on this topic is recommended.

7.7.5 Further Investigation into Porter's Thesis and Dashboard Approaches

From the review of the literature in this study what has emerged is that there is considerable congruence between Porter's thesis and the Dashboard approaches (as with the Balanced Scorecard). Both claim to explain causal relationships between actions and performance, thereby helping a company to reach its strategic goals more effectively. Both approaches seem to offer equal opportunities to answer the research question. However, after careful consideration of the available resources it emerged that this was unfeasible within the context of the present doctoral study without losing focus and reducing the depth of the investigation. Hence, a comparative study to investigate the usefulness of each approach in order to answer the research question is recommended.

7.8 Final Conclusions and Remarks

The enduring financial crisis has led to increasing pressure on universities to perform better and to an increasing interest in performance measurement as an instrument to reach that aim. The approach in the present research of considering what lessons are there to be learned from the corporate sector is nothing new, as shown in the following quote:

> *Until very recently economists have … treated the university as sacrosanct and have spent their energies looking out through its windows at the rest of the world instead of viewing their own natural habitat … they have spent thousands of man-years analysing the behaviour of business firms … and … any other variety of institution and have scarcely given a thought to that one with which they are most closely and dependently connected*

Cartter, 1965, pp. 481-482.

Within the context of similar studies as well as the related economics and management literature, it can be concluded that the evidence presented in this thesis is convincing and largely consistent with Porter's argumentation in his seminal work 'The competitive advantage of nations' (Porter, 1998) as well as with similar research successfully using the diamond model in UK higher education (Curran, 2001). The findings of the present research demonstrate that the presented adapted versions of Porter's diamond and *Four stages of competitive development* models are of a compelling simplicity and applicable in German higher education. They also facilitate an explanation and an understanding of the role and impact of the determinants of research performance which enables university decision makers to achieve their strategic objectives more successfully.

References

Abercrombie, N., Hill, S. and Turner, B.S. (2000) *The Penguin Dictionary of Sociology,* 4th edn. London: Penguin Books

Abramo, G., D'Angelo, C.A. and Caprasecca, A. (2009) 'Allocative efficiency in public research funding: can bibliometrics help?', *Research Policy,* 38 (1) pp. 206-215.

Acton, C. and Miller, R. (2009) *SPSS for social scientists*. 2nd. Edition. Basingstoke: Palgrave Macmillan.

Adcroft, A. and Willis, R. (2005) 'The (un)intended outcome of public sector performance measurement', *International Journal of Public Sector Management,* 18 (5) pp. 386- 400.

Adler, R., Ewing, J. and Taylor, P. (2008) Citation Statistics. Available at: https://www.timeshighereducation.com/news/average-citation-rates-by-field-1998-2008/405789.article?storyCode=405789 (Accessed 11 October 2015).

Aghion, P. and Tirole, J. (1997) 'Formal and real authority in organizations', *Journal of Political Economy,* 105 (1), pp. 1-29.

Allen, M.J. and Yen, W.M. (1979) *Introduction to Measurement Theory,* Long Grove, IL.: Waveland Press.

Alvesson, M. and Deetz, S. (2010) *Doing Critical Management Research,* London: SAGE.

Arthur, W.B. (1994) 'Positive feedbacks in the economy', *The McKinsey Quarterly,* no volume (1) pp. 81-95.

Auranen, O. and Nieminen, M. (2010) 'University research funding and publication performance – An international comparison', *Research Policy,* 39 (6) pp. 822-834.

Azoulay, P., Graff Zivin, J.S., and Wang, J. (2010) 'Superstar extinction', *The Quarterly Journal of Economics,* 125 (2) pp. 549-589.

Ball, D.F. and Butler, J. (2004) 'The implicit use of business concepts in the UK research assessment exercise', *R&D Management,* 34 (1) pp. 87-97.

Banks, R.L. and Wheelwright, S.C. (1979) ‘Operation vs. strategy: trading tomorrow for today’, *Harvard Business Review,* 57 (3) pp. 112-120.

Barnabe, F. and Riccaboni, A. (2007) ‘Which role for performance measurement systems in higher education? Focus on quality assurance in Italy’, *Studies in Educational Evaluation,* 33 (3-4) pp. 302-319.

Bazeley, P. (2010) ‘Conceptualising research performance’, *Studies in Higher Education,* 35 (8) pp. 889-903.

Beamon, B.M. (1999) ‘Measuring supply chain performance’, *International Journal of Operations & Production Management,* 19 (3) pp. 275-292.

Behrens, J.T. and Yu, C.-H. (2003) ‘Exploratory data analysis’, in Weiner, I. B. (ed.) *Handbook of Psychology,* New York: Wiley.

Benavent-Perez, M. Gorraiz, J. and Gumpenberger, C. (2012) ‘The different flavors of research collaboration: a case study of their influence on university excellence in four world regions’, *Scientometrics,* 93 (1) pp. 41-58.

Bessette, R. W. (2003) ‘Measuring the economic impact of university-based research’, *Journal of Technology Transfer,* 28 (3-4) pp. 355-361.

Bhaskar, R. (1975) *A Realist Theory of Science*, 2nd edn. Leeds: Leeds Books.

Blaikie, N. (2010) *Designing Social Research,* 2nd edn. Cambridge: Polity Press.

Bourke, P. and Butler, L. (1998) ‘Institutions and the map of science: matching university departments and fields of research’, *Research Policy,* 26 (6) pp. 711-718.

Braun, V. and Clarke, V. (2006) ‘Using thematic analysis in psychology’, *Qualitative Research in Psychology,* 3 (2) pp. 77-101.

Broadbent, J. (2010) ‘The UK research assessment exercise: performance measurement and resource allocation’, *Australian Accounting Review,* 52 (1) pp. 14-23.

Bryman, A. (2012) *Social Research Methods,* 4th edn., Oxford: University Press.

Butler, L. (2008) ‘Using a balanced approach to bibliometrics: quantitative performance measures in the Australian research quality framework’, *Ethics in Science and Environmental Politics,* 8 (1) pp. 83-92.

Carayannis, E. and Wang, V.W.L. (2012) ‘Competitiveness model - a double diamond’, *Journal of the Knowledge Economy,* 3 (3) pp. 280-293.

Cartter, A.M. (1965) ‘Economics of the University’, *Papers and Proceedings of the 77th Annual Meeting of The American Economics Association,* 55 (2) pp. 481-494.

Cave, M. and Weale, M. (1991) ‘The assessment: higher education – the state of play’, *Oxford Review of Economic Policy,* 8 (1) pp. 1-18.

Chandler, A. D. (1990) ‘The enduring logic of industrial success’, *Harvard Business Review,* 68 (2) pp. 130-140.

Cho, D.S. (1994) ‘A dynamic approach to international competitiveness: The case of Korea’, *Journal of Far Eastern Business,* 1 (1) pp. 17-36.

Cho, D-S, Moon, H-C, and Kim, M-Y. (2009) ‘Does one size fits all? A dual double diamond approach to country-specific advantages’, *Asian Business & Management,* 8 (1) pp. 83-102.

Clark, T. (1991) ‘Review of the Competitive advantage of nations, by M.E. Porter’, *Journal of Marketing,* 55 (4) pp. 118-120.

Cross, K.F. and Lynch, R.L. (1992) ‘For good measure’, *CMA Magazine,* 66 (3) pp. 20-23.

Crotty, M. (1998) *The foundations of social research: meaning and perspective in the research process.* London: Sage Publications Ltd.

Curran, P.J. (2001) ‘Competition in UK higher education: applying Porter’s diamond model to geography departments’, *Studies in Higher Education,* 26 (2) pp. 223-251.

Davies, H. and Ellis, P. (2000) ‘Porter’s competitive advantage of nations: time for the final judgement?’, Journal of Management Studies, 37 (8) pp. 1189-1213.

De Vos, H. and Kabat, D.J. (1968) 'Management services: financial management & controls'. *The Journal of Accountancy,* 125 (2) pp. 82-85.

Delanty, G. and Strydam, P. (eds.) (2010) *Philosophies of Social Science: the Classic and Contemporary readings.* Maidenhead: Open University Press.

Eccles, R.G. (1991) 'The performance measurement manifesto', *Harvard Business Review,* 69 (1) pp. 131-137.

Eilon, S. (1990) 'On competitiveness', *Omega: International Journal of Management Science,* 20 (1) pp. i-v.

Entman, R.M. (1993) 'Framing: towards clarification of a fractured paradigm', *Journal of Communication,* 43 (4) pp. 51-58.

Epstein, M.J. and Manzoni, J-F., (1997) 'The balanced score card and tableau de bord – translating strategy into action', *Management Accounting,* 79 (2) pp. 28-36.

European Ministers of Education (1999) *The Bologna Declaration of 19 June 1999*. Available at: www.ehea.info/.../BOLOGNA_DECLARATION1.pdf (Accessed: 14 December 2014).

Feller, I. (2002) 'Performance measurement redux', *American Journal of Evaluation,* 23 (4) pp. 435-452.

Filer, R.M., Furey, T.R., Pryor, L.S., and Rumburg, J.E. (1988) *Beating the competition: a practical guide to benchmarking*. Vienna, VA: Kaiser Associates.

Franco-Santos, M. Lucianetti, L. and Bourne, M. (2012) 'Contemporary performance measurement systems: a review of their consequences and a framework for research', *Management Accounting Research,* 23 (2) 79-119.

Fujita, M. Krugman, P. and Venables, A.J. *The spatial economy: cities, regions and international trade,* Cambridge MA: MIT Press.

Gandolfo, G. (1998) *International Trade Theory and Policy*, Berlin – Heidelberg: Springer.

Glass, C.J. Hyndman, N.S. and McKillop, D.G. (1996) ‘UK universities: a time-series study of economies of scale and scope in the context of the research assessment exercises’, *Public Money & Management,* 16 (4) pp. 59-64.

Gmür, M. (2003) Co-citation analysis and the search for invisible colleges: a methodological evaluation, *Scientometrics,* 57 (1) pp. 27-57.

Google Books (no date) Available at: https://books.google.nl (Accessed 20 September 2011).

Grant, R.M. (1991) ‘Porter’s Competitive advantage of nations: an assessment’, *Strategic Management Journal,* 12 (7) pp. 535-548.

Gray, D.E. (2013) *Doing Research in the Real World,* Los Angeles: SAGE.

Hakala, J. and Nieminen, M. (2002) ‘Research programs in Finland: steering effects and success from the perspective of project leaders’ , The 4th Triple Helix Conference*: Breaking Boundaries-Building Bridges*, Copenhagen, Denmark, 6.-9.11.2002. Available at: http://www.uta.fi/laitokset/yti/english/tasti/publications/electronic_library/hakalanieminen_thc02_paper.pdf (Assessed 6 February 2011)Harvey, D. (20011) *A brief history of neoliberalism,* 5th reprint, Oxford: Oxford University Press.

HEFCE (2009) *Research Excellence Framework – second consultation on the assessment and funding of research* Available at: http://www.hefce.ac.uk/pubs/year/2009/200938/name,63841,en.html (Accessed 12 January, 2015).

Henrekson, M. and Waldenström, D. (2011) ‘How should research performance be measured? A study of Swedish economists’, *The Manchester School,* 79 (6) pp. 1139-1156.

Himanen, L. , Auranen, O., Puuska, H-M, and Nieminen, M. (2009) ‘Influence of research funding and science policy on university research performance: a comparison of five countries’, *Science and Research Policy,* 36 (6) pp. 419-430.

Hood, C. (1991) ‘A public management for all seasons?’ *Public Administration,* 69 (1) pp. 3-19.

Hoover, E.M. (1937) *Localisation theory and the shoe and leather industry,* Cambridge MA: Harvard University Press.

Hoskin, K.W. and Macve, R.H. (2000) ‘Knowing more as knowing less? Alternative histories of cost and management accounting in the U.S. and the U.K.’, *Accounting Historians Journal,* 27 (1) pp. 91-149.

Howell, D.C. (2010) *Statistical methods for psychology,* 7th edn. Belmont: Wadsworth.

Jarratt, A. (1985) *Report [of the Committee of Vice-Chancellors and Principals of the Universities of the United Kingdom. Steering Committee for Efficiency Studies in Universities]* London: The Committee.

Jemric, I and Vujcic, B. (2002) ‘Efficiency of banks in Croatia: A DEA approach’, *Comparative Economic Studies,* 44 (2) pp. 169-193.

Johnes, J. and Johnes, G. (1995) ‘Research funding and performance in U.K. university departments of economics: a frontier analysis’, *Economics of Education Review,* 14 (3) pp. 301-314.

Kahn, P. (1996) ‘The decline of German universities’, *Science,* 273 (5272) pp. 172-174.

Kaiser Associates (no date) *Benchmarking process*. Available at: http://kaiserassociates.com/capabilities/benchmarking/benchmarking-process/ (Accessed: 7 April 2016).

Kaplan, R. S. (1984) ‘The evolution of management accounting’, *The Accounting Review,* 59 (3) pp. 390-418.

Kaplan, R.S. and Norton, D.P. (1992) ‘The balanced scorecard – measures that drive performance’, *Harvard Business Review,* 70 (1) pp. 71-79.

Kaplan, R.S. and Norton, D.P. (1996) *The balanced scorecard – translating strategy into action,* Boston: Harvard Business Review Press.

Keegan, D. P., Eiler, R.G. and Jones, C.R. (1989) 'Are your performance measures obsolete? Many companies have too many-and too many irrelevant ones', *Management Accounting,* 70 (12) pp. 45-50.

Kezar, A. (2005) 'Redesigning for collaboration within higher education institutions: an exploration into the developmental process', *Research in Higher Education,* 46 (7) pp. 831-860.

Kim, M-Y. (2006) 'Inequality in globalisation: an extension of the gini index from the perspective of national competitiveness', *Journal of International Business and Economy,* 7 (1) pp. 119-140.

Korhonen, P., Tainio, R. and Wallenius, J. (2001) 'Value efficiency analysis of academic research – theory and methodology', *European Journal of Operational Research,* 130 (1) pp.121-132.

Kuehn, T. (2002) *Universities and intellectuals: der englische Universitaetsroman der 70er und 80er Jahre im Kontext des Hochschuldiskurses,* Tuebingen: Narr.

Laitinen, E.K. (2003) 'Future-based management accounting: a new approach with survey evidence', *Critical Perspectives on Accounting,* 14 (3) pp. 293-323.

Lane, J. (2009) 'Assessing the impact of science funding', *Science,* 324 (5932) pp. 1273-1275.

Layder, D. (1998) *Sociological Practice: Linking Theory and Social research,* London: SAGE.

Lindsey, D. (1991) 'The relationship between performance indicators for academic research and funding: developing a measure of return on investment in science', *Sientometrics,* 20 (1) pp. 221-234.

Luneva, E.V. (2015) 'Key performance indicators (KPI) system in education', *Asian Social Science,* 11 (8) pp. 194-200.

MacColl, J. (2010) 'Library roles in university research assessment', *Liber Quarterly,* 20 (2) pp. 152-168.

Man, de, A.P. (1994) ‘1980,1985,1990: a Porter exegesis’, *Scandinavian Journal of Management*, 10(4) pp. 437-450.

Marcus Aurelius (2006) *Meditations,* London: Penguin Books

Martin, B.R. and Irvine, J. (1983) ‘Assessing basic research - some partial indicators of scientific progress in radio astronomy’, *Research Policy,* 12 (2) pp. 61-90.

Marty, T. (2012) ‘Clean up the waste’, *Nature,* 484 (7392) pp. 27-28.

Mautner. T. (2000) *The Penguin Dictionary of Philosophy,* London: Penguin Books.

Maynard, J. (1971) *Some Microeconomics of Higher Education - Economies of Scale,* Lincoln: University of Nebraska Press.

McAdam, R. and Walker, T. (2003) ‘An inquiry into balanced scorecards within best value implementation in UK local government’, *Public Administration,* 81 (4) pp. 873-892.

McGowan, J. (1998) *Hannah Arendt: An Introduction,* Minneapolis: University of Minnesota Press.

Merton, R.K. (1949) *Social Theory and Social Structure*, New York: Simon & Schuster.

Merton, R.K. (1988) ‘The Matthew effect in science, II, cumulative advantage and the symbolism of intellectual property’, *ISIS,* 79 (4) pp. 606-623.

Meyer, S. B. and Lunnay, B. (2012) ‘The application of abductive and retroductive inference for the design and analysis of theory-driven sociological research’, *Sociological Research Online,* 18 (1) pp. 1-12.

Moed, H. F., Luwel, M., Houben, J.A., Spruyt, E. and Berghe, van den, H. (1998) ‘The effects of changes in the funding structure of the Flemish universities on their research capacity, productivity and impact during the 1980’s and early 1990’s’, *Scientometrics,* 43 (2) pp. 231-255.

Mohrman, K., Ma, W. and Baker, D. (2008) ‘The research university in transition: the emerging global model’, *Higher Education Policy,* 21 (1) pp. 5-27.

Morrison, J.M. (2003) *A contribution to scientific knowledge.* Available at: http: //www.usb.ac.za/phd (accessed 30 September 2015).

Moustakas, C.E. (1994) *Phenomenological research methods,* Thousand Oaks: SAGE Publications, Inc.

Myint, H. (1977) 'Adam Smith's theory of international trade in the perspective of economic development', *Economica New Series,* 44 (175) pp. 231-248.

Neely, A. (2005) 'The evolution of performance measurement research – developments in the last decade and a research agenda for the next', *International Journal of Operations & Production Management,* 25 (12) pp. 1264-1277.

Neely, A.(ed.) (2007) *Business performance measurement - Unifying theories and integrating practice,* 2nd edn. Cambridge: University Press.

Neely, A., Gregory, M. and Platts, K. (1995) 'Performance measurement system design – a literature review and research agenda', *International Journal of Operations & Production Management',* 15 (4) pp. 80-116.

Nigsch, S. and Schenker-Wicki, A. (2015) Frontier efficiency analysis in higher education, in Welpe, I.M. et al., (eds.) *Incentives and performance: governance of research organisations,* Heidelberg etc.: Springer, pp. 155-170.

Nilsson, F. and Olve, N-G. (2001) 'Control systems in multibusiness companies: From performance management to strategic management', *European Management Journal,* 19 (4) pp. 344-358.

Nørreklit, H. (2000) 'The balance on the balanced scorecard – a critical analysis of some of its assumptions', *Management Accounting Research,* 11 (1) pp. 65-88.

Olsen, J.P. (1988) 'Administrative reform and theories of organization', in Campbell, C. and Peters, B.G. (eds.) *Organizing Governance: Governing Organizations.* Pittsburgh: University of Pittsburgh Press, pp. 236-242.

Ong, B.K. (2012) 'Grounded theory method (GMT) and the abductive research strategy (ARS): a critical analysis of their differences', *International Journal of Social Research methodology,* 15 (5) pp. 417-432.

Oppenheim, C. (1995) ‘The correlation between citation counts and the 1992 research assessment exercise ratings for British library and information science university departments’, *Journal of Documentation,* 51 (1) pp. 18-27.

Oppenheim, C. (1997) ‘The correlation between citation counts and the 1992 research assessment exercise ratings for British research in genetics, anatomy and archaeology’, *Journal of Documentation,* 53 (5) pp. 477- 487.

Orr, D. (2004) ‘Research assessment as an instrument for steering higher education – a comparative study’, *Journal of Higher Education Policy and Management,* 26 (3) pp. 345-362.

O’Sullivan, A. and Sheffrin, S.M. (2003) *Economics: principles in action*, Upper Saddle River, N.J.: Pearson Prentice Hall.

Paul, R.J. (2008) ‘Measuring research quality: the united kingdom government’s research assessment exercise’, *European Journal of Information Systems,* 17 (4) pp. 324-329.

Pike, S. and Roos, G. (2007) ‘The validity of measurement frameworks: measurement theory’, in Neely, A. (ed.) *Business performance measurement,* Cambridge: Cambridge University Press, pp. 218-235.

Porter, M.E. (1985) *Competitive advantage – creating and sustaining superior performance,* New York: The Free Press.

Porter, M.E. (1998) *The competitive advantage of nations –with a new introduction,* New York: The Free Press.

Pritchard, A. (1969) ‘Statistical bibliography or bibliometrics?’, *Journal of Documentation,* 25 (4) pp. 358-359.

RAE (no date) Available at: http://www.rae.ac.uk/aboutus/history.asp (Accessed 8 october 2011).

REF (2011) Available at : http://www.ref.ac.uk/pubs/2011-01/ (Accessed 23 June 2015).

Research in Germany (2014) Available at: http://www.research-in-germany.de/dachportal/en/Research-Landscape/Research-Organisations/Universities.html (Accessed: 21 October 2014).

Reynolds, P. D. (2007) *Primer in theory construction,* Upper Saddle River, NJ: Pearson Education, Inc.

Ridgway, V.F. (1956) 'Dysfunctional consequences of performance measurements', *Administrative Science Quarterly,* 1 (2) pp. 240-247.

Ringelhan, S., Wollersheim, J. and Welpe, I.M. (2015) 'Performance management and incentive systems in research organizations: effects, limits and opportunities', in Welpe, I.M. et al., (eds.) *Incentives and performance: governance of research organisations,* Heidelberg etc.: Springer, pp. 87-103.

Ruffin, R.J. (2002) 'David Ricardo's discovery of comparative advantage', *History of Political Economy,* 34 (4) pp. 727-748.

Rugman, A.M. (1991) 'Diamond in the rough', *Business Quarterly,* 56 (3) pp. 61-64.

Rugman, A.M. (1992) 'Porter takes the wrong turn', *Business Quarterly,* 57 (3) pp. 59-64.

Sayer, A. (2000) *Realism and Social Science,* London: SAGE.

Schubert, T. and Sooryamoorthy, R. (2010) 'Can the centre-periphery model explain patterns of international scientific collaboration among threshold and industrialised countries? The case of South Africa and Germany', *Scientometrics,* 83 (1) pp. 181-203.

Schumacher, R. (2012) 'Adam Smith's theory of absolute advantage and the use of doxography in the history of economics', *Erasmus Journal for Philosophy and Economics,* 5 (2) pp. 54-80.

SciVal (no date) Available at: www.scival.com (Accessed: 21 January 2015).

Scopus (no date) Available at: www.scopus.com (Accessed: 16 December 2014).

Scott, R. and Lodge, G. (1985) *US competitiveness in the world economy.* Boston: Harvard University Press.

Sheikh, A. (2000) ‘Publication ethics and the research assessment exercise: reflections on the troubled question of authorship’, *Journal of Medical Ethics,* 26 (6) pp. 422-426.

Shore, C. and Wright, S. (1999) ‘Audit culture and anthropology: neo-liberalism in British higher education’, *Journal of the Royal Anthropological Institute,* 5 (4) pp. 557-575.

Simmie, J. (2004) ‘Innovation and clustering in the globalised international economy’, *Urban Studies,* 41 (5/6) pp. 1095-1112.

Sizer, J. and Durnin, J. (1998) ‘The encouragement of collaboration between higher education institutions in a period of financial stringency’, *Tertiary Education and Management,* 4 (2) pp. 123-131.

Smulowitz, S. (2015) ‘Evidence for the performance prism in higher education’, *Measuring Business Excellence*, 19 (1) pp. 70-80.

Snowball metrics (2012) Available at: www.snowballmetrics.com/metrics (Accessed 20 January 2015).

Speckbacher, G., Bischof, J. and Pfeffer, T. (2003) ‘A descriptive analysis on the implementation of balanced scorecards in German-speaking countries’, *Management Accounting Research,* 14 (4) pp. 361-387.

Steele, C., Butler, L. and Kingsley, D. (2006) ‘The publishing imperative: the pervasive influence of publication metrics’, *Learned Publishing,* 19 (4) pp. 277-290.

Stephan, P. (2012) ‘Perverse incentives’, *Nature,* 484 (7392) pp. 29-31.

Stevenson, A. and Waite, M. (eds.) (2011) *Concise Oxford English Dictionary,* 12th edition, Oxford: University Press.

Strathern, M. (1997) ‘From improvement to enhancement: an anthropological comment on the audit culture’, *The Cambridge Review,* pp. 118 (November) pp. 117-126.

Tambi, A.M.B.A, Ghazali, M.C. and Yahya, N.B. (2008) ‘The ranking of higher education institutions: a deduction or delusion?’, *Total Quality Management,* 19 (10) pp. 997-1011.

Tapinos, E., Dyson, R.G., and Meadows, M. (2005) ‘The impact of the performance measurement systems in setting the ‘direction’ in the University of Warwick’, *Production, Planning & Control,* 16 (2) pp. 189-198.

Tashakkori, A. and Teddlie, C. (2010) ‘Putting the human back in “human research methodology”: the researcher in mixed methods research’, *Journal of Mixed Methods research,* 4 (4) pp. 271-277.

Triantafillou, P. (2007) ‘Benchmarking in the public sector: a critical conceptual framework’, *Public Administration,* 85 (3) pp. 829-846).

Tukey, J.W. (1980) ‘We need both exploratory and confirmatory’, *The American Statistician,* 34 (1) pp. 23-25.

Vernon, R. (1966) ‘International investment and international trade in the product cycle’, *Quarterly Journal of Economics,* 80 (2) pp. 190-207.

Vogel, P.P. (1968) ‘Round 2 in international business’, *Business Horizons,* 11 (4) pp. 57-62.

Voges, K.E. (2009) ‘Cluster analysis using rough clustering and k-Means clustering’, in Khosrow-Pour, M. (ed.) *Encyclopaedia of Information Science and Technology,* Hershey: IGI Global.

Wallerstein, I. (1976) *The Modern World-System: Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century,* New York: Academic Press.

Warning, S. (2004) ‘Performance differences in German higher education: empirical analysis of strategic groups’, *Review of Industrial Organization,* 24 (4) pp. 393-408.

Weingart, P. (2005) ‘Impact of bibliometrics upon the science system: inadvertent consequences?’, *Scientometrics,* 62 (1) pp. 117-131.

Wellings, P. and Winzer, R. (2011) *Mapping Research Excellence: Exploring the Links between Research Excellence and Research Funding Policy,* No place: 1994Group. Available at: http://www.elsevier.com/online-tools/research-intelligence/resource-library/resources/mapping-research-excellence-exploring-the-links-between-research-excellence-and-research-funding-policy (Accessed: 10 April 2015).

Williams, M. (2000) 'Interpretivism and generalisation', *Sociology,* 34 (2) pp. 209-224.

Wissenschaftsrat (no date) *Excellence Initiative.* Available at: www.wissenschaftsrat.de (Accessed 14 February 2015).

Woodward-Kron, R. (2002) 'Critical analysis versus description? Examining the relationship in successful student writing', *Journal of English for Academic Purposes,* 1 (2) pp. 121-143.

Yamey, B. S. (1947) 'Notes on the origin of double-entry bookkeeping', *Accounting Review,* 22 (3) pp. 263-272.

Yin, R.K. (2009) *Case Study Research,* 4th edn. Los Angeles: SAGE.

Zikmund, W.G. (2000) *Business Research Methods,* 6th edn. Orlando: Harcourt.

APPENDICES

Appendix 1: Summary of precedent studies relating to performance measurement in the corporate sector.

Author(s) and Year	**Topic**	**Key findings**	**Key variables**
	Development of frameworks		
Neely (2007)	Origins of accounting performance measurement (13th century)	*Accounting performance measurement* emerged alongside the development of double-entry bookkeeping.	
Kaplan (1984)	Cost, productivity and use of raw material reports (first half of 1800s)	Cost accounting systems provide managers of textile mills and railroads with *cost, productivity and use of raw materials reports* to monitor the efficiency of their firms.	Costs, productivity and use of raw materials
Kaplan (1984)	Adaption of accounting systems to generate performance reports (second half 1800s)	In the late 19th century emerging mass distribution and mass production enterprises adapted the accounting systems of the railroads to generate *performance reports* very similar to those that	Costs, productivity and use of raw materials

		would be used in the following 100 years to monitor a firm's performance	
Epstein and Manzoni (1997)	Tableau de Bord (1990s)	Emergence of one of the first performance measurement frameworks: *Tableau de Bord*, a reporting device offering a succinct overview using a few financial and non-financial parameters. Implementation often fell short.	Financial and non-financial measures
Kaplan (1984)	Du Pont pyramid of financial ratios with ROI ratio (1910s)	Development of *Du Pont pyramid of financial ratios* including the ROI ratio – the archetype of modern reporting and evaluation systems	Financial measures
Kaplan (1984)	1910-1970s	No major innovations in management accounting systems	
Keegan Eiler and Jones (1989)	Performance Measurement Matrix (1989)	*Performance Measurement Matrix* supplements financial with non-financial measurements and combines internal performance measurement with external comparisons to reflect the need for a 'balanced' measurement system.	Financial and non-cost criteria and benchmark data

Neely (2007)	Results-determinants framework (1991)	The need to identify the right drivers of performance to achieve the desired strategic objective is reflected in the '*Results-determinants framework'* as developed by Fitzgerald et al. in 1991. The strength of this framework is in its reflection on the causal relationship between specific determinants of past performance and current results.	Financial and non-financial measures
Cross and Lynch (1992)	Performance Pyramid (1992)	The *Performance Pyramid* includes internally and externally focused performance measures, reflecting both the corporate vision and the SBU's objectives. Companies must improve at the same rate or faster than the competition or will fall behind or drop out of the market.	Financial and non-financial measures
Kaplan and Norton (1992)	The Balanced Scorecard (1992)	In the *Balanced Scorecard* are financial measures supplemented by operational measures which are regarded as the drivers of performance. Performance is viewed from four perspectives. The Balanced scorecard is unique in linking	Financial measures supplemented with operational measures

		performance drivers with outcome measures in a causal relationship.	
Neely (2007)	Input-process-output-outcome framework (1996)	Brown's *Inputs-processing systems-outputs-outcomes-goals* model is based on the assumption of a linear relationship between the elements of the system. This framework is particularly popular in the public sector because it recognises the importance of *delighted customers* and *meeting customers' needs.*	Financial, process and operational, product/service and customer measures.
Neely (2007)	Business Excellence Model (2002)	The Business Excellence Model developed by the European Foundation for Quality Management is based on self-assessment rather than objective measurements. It results are readily measurable but the enablers are not.	Quantitative measures and indicators of qualitative estimations
Neely (2007)	The Performance Prism (2007)	The Performance Prism features the novelty of the stakeholder-centric perspective	Measures designed using the performance measures design template

	Measures		
Ridgway (1956)	Inadequacy of single measures (1940s)	No single measure is adequate to measure the success of a firm; dysfunctional consequences of the use of inadequate measures emerge.	Single measures
Ridgway (1956)	Emergence of multiple measures (early 1950s)	Multiple measures emerge to substitute inadequate single measures. Emphasis on one measure might lead to de-emphasis on other measures.	Multiple measures
Ridgway (1956)	Development of composite measures (mid-1950s)	Development of composite measures to ‘balance’ the emphasis on contradicting measures. Owing to a lack of opportunity for compensation, raising the composite score puts the whole organisation under pressure.	Composite measures
Neely (2007)	ROI-ratio (> 1950s)	The ROI-ratio becomes the ultimate economic measure of business performance	Financial measures
Chandler (1992)	Reliance on financial measures (late 1960s-early 1970s)	Head office managers of diversified firms, missing the experience to monitor performance and rely heavily on financial measures	Financial measures

Neely Gregory and Platts(1995)	Cost of finding measures (late-1980s)	General Electric invested in the late -1980s $ 20 M to identify >60 primary measures	Financial and non-financial measures
Eccles (1991)	Continuing dominance of financial measures (1991)	Dominance of financial measures is explained by preference of investors for these measures. Until this changes other measures will not be taken seriously.	Financial measures
	Impact on professional practice		
Eccles (1991)	Investments in measures beyond financial ones (1951)	By 1951 General Electric had commissioned a high level task force to identify key corporate measures beyond the ‘classical’ financial measures.	Financial and non-financial measures
De Vos and Kabat (1968)	Shortcomings of financial measures	Financial measures do not do full justice to the complexity of performance and can lead to short-termism.	Financial measures
Eccles (1991)	Shortcomings of financial measures (1980s)	Single focus on financial measures ignores impacts of non-financial attributes of performance.	Financial measures

Kaplan (1984)	Three types of short-termism (1984)	There are three types of short-termism: (1) exploitation of accounting conventions; (2) engagement in financial rather operational entrepreneurship; (3) short-term opportunistic behaviour.	
Aghion and Tirole (1997)	Contradicting explanations of the origins of dysfunctional behaviour (1997)	The ‘principal-agent dilemma’ explains that performance measurement reduces the ‘agents’ performance, whereas the ‘control-theory’ suggests the opposite.	

Appendix 2: Summary of precedent studies related to performance measurement in higher education

Author(s) and Year	**Topic/ Approach**	**Method**	**Key findings**	**Theoretical framework**
	Frame-works			
Strathern (1997)	Qualitative	Case study	Origins of performance measurement in higher education lie in the development of written examinations in the late 1700s, which in the 19^{th} century became the inspiration for human accounting in the corporate sector.	*Cultural replication* derived from anthropology
Paul (2008)	Qualitative	Observatio n	Numerical recognising and practical methods for measuring were recognised in the late 1880s as the foundations of developing a knowledge (Lord Kelvin).	Positivism
Feller (2002)	Qualitative	Case study	Performance measurement in US higher education emerged alongside the 2nd academic revolution (1960-2000) when faculty judgments and collegial reading were replaced by bibliometrics.	Perrin-Bernstein-Winston debate
Kuehn (2002)	Qualitative	Case study	The introduction of performance measurement in UK higher education goes back to the 1980s when accountability was viewed as technology to introduce the values and practices of the private sector in the public sector, in line with the views of the Jarratt-report.	Neoliberalism

RAE (no date)	Qualitative	Case study	The RAEs - the first explicit and formalised assessment of the quality of research proved a major impetus for research assessment in higher education.	
Oppenheim (1995)	Quantitative	Case study	The RAE rankings were reasonably realistic, but the use of panels was very costly.	Bibliometrics
Glass, Hyndmann and McKillop (1996)	Quantitative	Time-series study	To fill the gap of empirical evidence that accountability made universities more productive, the 'Two-input 3-output model' was developed, comprising the input of capital and labour and the output of undergraduate and postgraduate education and research.	Economic analysis
Porter (1998)	Quantitative and qualitative	diamond model	The diamond model explains how four broad attributes shape the environment in which competitive advantage is created or impeded. Truly innovative research departments are increasingly independent of their institutional resources, have long-term views, create clusters with equally successful partners and are prepared to take risks.	Management theories
Curran (2001)	Quantitative and qualitative	Four stages of competitive development model	Porter's *four stages of competitive development* model was used in 2001 in UK higher education to locate research departments by their competitiveness vis-à-vis their peer group. The model explains the characteristic sources of competitiveness at each stage of competitive development and draws on Porter's diamond model.	Management theories

Korhonen, Tainio and Wallenius (2001)	Quantitative	Data Envelop-ment Analysis	Data Envelopment Analysis facilitates "scientifically" evaluate research by calculating *value efficiency scores.* The difficulty is to find the perfect indicators: *number of papers* lead to short-termism and *number of citation*s can be manipulated.	Linear programming methodology
Orr (2004)	Qualitative	Case study	In the mid-2000s in Europe the RAEs became the archetype of research assessments in higher education its various adaptations can be captured in the generic *Framework for research assessment design*. Theses possible adaptations involve seven areas: (1) ownership of the evaluation unit; (2) the presence of (non-)academics and/or (international)/national academics; (3) formalised or self-chosen criteria; (4) the (non-)recognition of existing structures; (5) output vs. process orientation; (6) ex-post or ex-ante evaluation; (7) bonus or bonus/malus consequences.	Framework of New Public Management
Abramo, D'Angelo and Caprasecca (2009)	Quantitative	Case study	The first national research assessment in Italy was in 2006; this comprised only 14% of all output and therefore cast doubt on the representativeness of the assessed submissions. In 6 of the 8 disciplines papers were submitted below the median quality. These outcomes suggest that the selection of papers for submission was the weakest phase in the process.	Bibliometrics
MacColl (2010)	Qualitative	Descriptive analysis	The *Research environments* model depicts the relationship between researchers and assessments. The model comprises 4 overlapping	

		and model building	environments, including the *Assessment* environment. Here, account beneficiaries of funding for their expenditures and demonstrate their value. It is suggested that in the overlap of the environments *Domain, Assessment* and *Institution* academic libraries could be (more) involved in research assessments by making research performance more visible.	
Bazeley (2010)	Quantitativ e/Qualitativ e	Integrated mixed methods	The *Conceptual model of the dimensions of research performance* acknowledges *Research activity* and *Performing – making [research] visible* as the two key dimensions of research performance. The relationship between the dimensions in the model is, however, ontological rather than causal. The model acknowledges three different types of research outcomes: products (= publications), impact and reputation.	Phenomenographic
	Measures			
Martin and Irvine (1983)	Quantitativ e/Qualitativ e	Integrated mixed methods	One of the first studies of research performance in the early 1980s used *converging partial indicators*, this constituting publications, citations and peer review . Here, past performance was viewed as one of the best indicators of future performance.	
Weingart (2005)	Qualitative	Case study	A commercial company holds the monopoly of the data used in quantitative performance assessments in higher education. The accountability *hype* has moved bibliometric measures from niches in academia to a strategic	

			position in policy making where they can be misleading and even destructive. Additionally, little is known about the impact of performance measurement on the higher education system (institutions and researchers).	
Oppenheim, C. (1995 and 1997)	Quantitative	Case study	Investigating the correlation between the judgments of the panel system of the 1992 RAE and counting citations by using an abstract and citation database showed a strong correlation, suggesting that much public money could be saved by substituting peer review with bibliometrics. This was also found in a later study of a larger research field by the same author, indicating that disruptions due to the incompleteness of the data source were not great. It was concluded that citation counts should suggest the *rank order*, whereas peer panels should assign the RAE scores.	Derived from bibliometrics
Sheikh (2000)	Qualitative	Case study	Adding economic considerations may have an impact on authorship issues, as for example, *gift* and *ghost authorships*. The RAE lacks a mechanism to accurately assess the individual contributions of multiple author papers.	Publication ethics
Korhonen, Tainio and Wallenius (2001)	Quantitative		In the early 2000s was found that universally accepted methods to scientifically assess research performance were lacking. Here, there were key questions about which criteria were relevant and which indicators for each criterion were still unanswered	

Curran (2001)	Quantitativ e	Case study	An initial dataset of thirty-six departmental and institutional variables from twenty-eight different sources was tested as attributes of the competitive advantage of geography departments in the UK. A comparatively large number of variables was tested because no single variable could be found showing a sufficiently strong causal relationship with any of the four corners of the diamond; it was also determined that the variables were all strongly inter-correlated. Here, at least 90% of the variability resided in thirteen dimensions. The first three of these dimensions accounted for 53% of the variability and were all related to the parent-institute and not to the assessed department. Strong relationships with performance were found with the variables: research orientation; size and income; demand for departmental expertise; the presence of clusters of successful departments; the number of *academic stars*; the ability to do research, attract funding and educate students.	Regression analysis
Feller (2002)	Qualitative	Case study	The US National Academy of Sciences suggested that research cannot be meaningful evaluated through the use of quantitative measures with a numerical indicator; they recommend that a return to expert panels for evaluation should be reconsidered.	Perrin-Bernstein-Winston debate
Weingart, P. (2005)	Qualitative	Case study	The advantage of bibliometric indicators is that they eliminate personal bias; they are arrived at as a result of decisions that are not motivated by evaluation considerations and are determined by a larger number of publications. Their strength is	Research based social technology

			that they can reveal macro-patterns. However, methodological bias may occur because of a lack of *robustness* in their data source.	
Steele, Butler and Kingsley (2006)	Qualitative	Case study	A large number of the publications challenging the usefulness of numerical indicators criticise their most dominant representative: the *Journal Impact Factor* and its data source Web of Science; these highlight bias because particular countries and disciplines are favoured and because of shortcomings in the overall coverage. In the context of the debate concerning the shortcomings of the Web of Science, is it surprising that researchers and research performance assessors have not shifted significantly to Elsevier's Scopus database. This became available in 2004 and covered twice as many journals.	Eclectic
Butler, L. 2008	Qualitative	Case study	The 2008 Australian RQF introduced quantitative metrics alongside peer review based on the assumption that neither approach alone could provide error-free judgements and therefore a combination of both methods was to be preferred. Bibliometrics were preferred above web, collaboration and contextual metrics as well as *Journal Impact Factors*. Each discipline used its own set of metrics. Here, for the social sciences and the A&I, alternative data extraction methods were designed because of their limited coverage in the Web of Knowledge.	Derived from bibliometrics

Henrekson and Waldenström, 2011	Quantitativ e	Biblio-metric analysis	About 3 decades after the first research assessment in the UK, there is still no consensus about what measures to use and how to conduct the assessment. The *optimal* measure, this diverging least from the other seven most common used measures, is the *Journal Impact Factor*.	Derived from bibliometrics
1994Group (2011)	Quantitativ e	Biblio-metric analysis	*Research competencies* constitutes one of the latest developed metrics making it possible to assess research performance from novel perspectives. The health and dynamics of *research competencies* should be taken into consideration when assessing research performance. Here, the growth-share matrix allows a depiction of research competencies according to the dimensions *growth* and *share* to identify the most likely successful research areas.	Derived from bibliometrics
Snowball metrics (2012)	Quantitativ e	Biblio-metric analysis	The Snowball initiative by research intensive universities worldwide attempts to come to globally standardised measures of research performance which allow benchmarking and cover the whole spectrum of academic research. To date, 24 metrics have been defined	Bibliometric analysis
	Impact on profession -nal practice			
Glass, Hyndmann and McKillop (1996)	Quantitativ e	Time-series study	The impact of the 1989 and 1992 RAEs increased overall efficiency. However, the RAE 1992 results showed only increasing returns to scale for the top	Economic analysis

			and middle universities. Here, efficiency improving investments in research have led to a diminishing impact. These results also showed increased product-specific economies of scale for research and postgraduate teaching for all the subgroups. Here, the highest increased product-specific economies of scale were found with the top universities. There were decreased economies of scope for undergraduate teaching for all subgroups.	
Bourke and Butler (1998)	Quantitativ e	Case study	The choice of university departments as Unit of Analysis (UoA) in research assessments have impacted on the assessed universities by obscuring important features of modern research and influencing the publishing behaviour of researchers. Departments in a discipline with an average low *citation per publication* (ccp) rate who publish relatively frequently outside their discipline may compare favourable against departments who publish more within their own discipline.	Derived from bibliometrics
Shore and Wright (1999)	Qualitative	Case study	Government attempts to introduce managerial technologies, such as audits in universities, have also impacted on the emergence of a new category of staff in higher education, encompassing functionaries such as *quality assurance officers.* Such attempts have also impacted strategically with a shift in priorities from researching and teaching to competitive wealth creation, establishing greater links between scientists and business people and more	Anthropology

			responsiveness to industry, commerce and government.	
Warning (2004)	Quantitativ e	Data Envelop-ment Analysis	In German higher education, the average efficiency in teaching is significantly higher than in research and the average efficiency in the natural sciences is significantly higher than in the social sciences.	Porter's *strategic performance-based groups* and *entry barriers* concepts
Ball and Butler (2004)	Qualitative	Case study	In the corporate and the higher education sector, both firms and universities seek to combine knowledge and expertise in response to increasing competition. Here universities with high rankings are favoured as collaborators and university research departments experience more autonomy to decide on the direction of their research. The evolution of performance measurement proceeds similarly in each sector. A shift is emerging from a focus on assessing individual organisations towards a focus on understanding inter-firm dynamics and how clusters and networks are developing and being managed.	Concepts from the R&D management literature
Adcroft and Willis (2005)	Qualitative	Case study	RAE-type assessments inform organisations on where they stand, but do not inform organisations about what they should do to perform better. When the higher education sector imports corporate sector performance measurement practices, it should at the same time also import the lessons learned with these practices in that sector. A number of systematic errors in the RAEs, in part overlapping with those reported in the corporate section literature, impede the desired	Drucker's rationale that "what one organization does, any other organization can do as well"

			results of measuring performance. Two further impacts of performance measurement in higher education are the *commodification of servi*ces and the *de-professionalization of workers.*	
Steele, Butler and Kingsley (2006)	Qualitative	Case study	The impact of rewarding publishing in high *Journal Impact Factor* journals has created a *Publishing obesity* so that the aim of publishing is no longer the dissemination of research results but rather the gains in the reward system, which has led to increasing rejection rates, often of 90% and higher for the top-cited journals,	Eclectic
1994Group	Quantitativ e	Co-citation analysis	Targeted and competitive research funding policies impact on the areas of national research excellence	